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Industrial Assessment Center Program Impact Evaluation

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ACRONYMS

ACEEE	American Council for an Energy Efficient Economy
AEE	Association of Energy Engineers
AR	assessment recommendation
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BTU	British Thermal Units
BBTU	billion BTU
CBR	Comprehensive Benefit Ratio
CSU	Colorado State University
DOE	U.S. Department of Energy
DOE-NICE(3)	Department of Energy-National Industrial Competitiveness through Energy, Environment, and Economics
DSM	demand side management
EE	energy efficiency
ES	Executive Summary
EREN	Energy Efficiency and Renewable Energy Network
FY	fiscal year
HVAC	heating, ventilation, and air conditioning
IAC	Industrial Assessment Center
IP	Internet Protocol
MMBTU	million BTU
OIPEA	Office of Industrial Productivity and Energy Assessment
OIT	Office of Industrial Technologies
pdf	portable document format
R&D	research and development
ROI	return on investment
RR	realization rate
SIC	standard industry code

ABSTRACT

This report presents the results of an evaluation of the U.S. Department of Energy's Industrial Assessment Center (IAC) Program. The purpose of this program is to conduct energy, waste, and productivity assessments for small to medium-sized industrial firms. Assessments are conducted by 30 university-based industrial assessment centers. The purpose of this project was to evaluate energy and cost savings attributable to the assessments, the trained alumni, and the Websites sponsored by this program. How IAC assessments, alumni, and Web-based information may influence industrial energy efficiency decision making was also studied. It is concluded that appreciable energy and cost savings may be attributed to the IAC Program and that the IAC Program has resulted in more active and improved energy-efficiency decision making by industrial firms.

ACKNOWLEDGMENTS

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EXECUTIVE SUMMARY

ES.1. INTRODUCTION

Oak Ridge National Laboratory (ORNL) is assisting the Industrial Assessment Center (IAC) Program, Office of Industrial Technologies (OIT), U.S. Department of Energy (DOE), in meeting the requirements of the Government Performance and Results Act of 1993 (GPRA). The IAC Program provides small and medium-sized manufacturers with energy, waste, and productivity assessments. These assessments are prepared by teams of engineering students and faculty from 30 colleges and universities across the country. Presently, the IAC Program uses a well-established database (Muller, Barnish, and Kasten 1998) to track savings resulting from recommendations generated during IAC site assessments.

There are, however, additional benefit pathways of the IAC Program that are not quantified in the current database. These include (1) assessment pathway benefits—through replication and implementation of (initially unimplemented or delayed) energy and cost savings recommendations; (2) alumni pathway benefits—through the training of students who will then find jobs in industry where they can use their IAC Program training; and (3) Website pathway benefits—through Web-based dissemination of technical information on energy and cost savings to organizations throughout the United States. This report presents methods used to measure the benefits attributable to the IAC Program from these pathways and estimates of these benefits.

This executive summary first presents the aggregated estimates of source energy savings, energy cost savings, and total cost savings attributable to the IAC Program for the year 1997 (Sect. ES.2). The data that were collected and methodologies employed to develop the estimates are discussed in Sects. ES.3 and ES.4, respectively. How the three IAC Program interventions may have impacted industrial energy-efficiency (EE) decision making is discussed in Sect. ES.5. Recommendations are presented in Sect. ES.6. Details of this study may be found in the report titled "Industrial Assessment Center Program Impact Evaluation," by Martin et al. (1999).

ES.2. AGGREGATE RESULTS

Table ES.1 presents the estimated source energy savings, energy cost savings, and total cost savings (including waste minimization and productivity activities) attributable to the IAC Program from each of the three pathways studied:

- direct assessments conducted for IAC client firms;
- student alumni of the IAC Program who may have jobs with responsibilities that entail reducing energy use and costs; and
- IAC Program Websites that can provide organizations with information about how to save energy and reduce costs.

Table ES.1 is meant to be a side-by-side illustration of the potential impacts of the three pathways, and is based on specific, conservative interpretations of the data from the three studies. Because of the limitations set forth by the data that were available for the study, flexibility in interpretation is feasible. Alternative interpretations, however, must consider all of the evidence, as documented in the full report.

Table ES.1. Estimated IAC Program annual savings for FY 1997 — assessment, alumni, and Website pathways

Program Component	Source Energy Savings (BBtu)	Energy Cost Savings	Total Cost Savings
Assessments	1,901	$9,327,630	$42,632,149
Alumni	3,368	$56,000,000	$66,650,000
Websites[a]	6,054	$26,870,800	$29,104,150
Total	11,323	$92,198,430	$138,386,299

[a] Domestic savings only

ES.3. DATA

The results presented were developed using data collected from follow-up questionnaires with firms (clients) that have received IAC assessments, with IAC student alumni, and with IAC Website users. Each questionnaire was designed primarily to collect data on energy and cost savings attributable to the IAC Program (Martin et al. 1999). However, several questions were added to each questionnaire to explore changes in EE decision making. Each follow-up effort is briefly described below.

ES.3.1 Client Follow-up

Since the inception of the IAC Program in the early 1980s, thousands of small and medium-sized industrial firms have received assessments. For this project, the sampling frame included all firms assessed between October 1, 1991, and September 30, 1997, that implemented or planned to implement at least one recommended EE measure, as recorded in the IAC database. From this frame of 2,954 firms, 102 were randomly selected and 42 agreed to be included in the follow-up. Of the 102 firms included in this sample, 37 could not be contacted because either the original contacts had left, or the plant or center was no longer in existence. Only 23 firms actually refused to participate. Therefore, of the 65 firms contacted, 42 participated, yielding a participation rate of 65%.

ES.3.2 IAC Alumni Follow-up

A database of 656 IAC alumni (out of an estimated 1,420 alumni through FY 1998) was obtained from Rutgers University. From these 656, IAC directors identified 77 alumni believed to be particularly successful in working in industry to save energy. In the spring of 1999, all 656 IAC alumni received a questionnaire in the mail. Two reminder cards were also sent. These three rounds of effort yielded 132 completed questionnaires. Approximately 150 questionnaire packages were returned as a result of bad addresses. Thus, the overall response rate was just over 26%.

ES.3.3 IAC Website Users Questionnaire

An on-line questionnaire of IAC Website users was conducted during a 96-day period in the spring of 1999. Visitors to IAC Websites maintained by DOE, Rutgers University, and Colorado State University were alerted to the questionnaire through an active Java applet on the home pages of these Websites. Visitors were induced to complete the questionnaire with a reward of an ASHRAE Pocket Guide. Twenty-nine responses were received during this time period. Because accurate usage summaries of these sites were not available, a response rate could not be determined.

ES.4. METHODOLOGY

Separate methodologies were used to estimate energy and cost savings impacts attributable to the IAC assessments, alumni, and Websites. These are described briefly below.

ES.4.1 Assessment Methodology

The approach taken to estimate savings was to adjust implemented energy and cost savings reported in the IAC database of client assessments. This was achieved using comprehensive benefit ratios, or CBR's. It is assumed that for measures implemented by IAC clients, the energy and cost savings estimates provided by the assessments are close to actual performance. CBR's are estimated to account for firms implementing more or less of the measures recommended in the assessments, and replication of recommended measures in other parts of the plant or at other plants that interact with the original IAC clients.

The client follow-up questionnaire collected data about the status of all assessment recommendations and replications. The CBR applied to source energy savings to calculate the result presented in Table ES.1 is 1.084. The CBR's for the energy cost savings and total cost savings are 1.004 and 1.15, respectively.

ES.4.2 Alumni Methodology

The alumni respondents to the follow-up questionnaire reported on their activities in saving energy and costs in the years 1995–1998. Energy and cost savings reported by the 132 respondents were generalized to the entire population of 1,420 alumni. This was done by assuming that the 26% response rate would have been the same had all alumni received follow-up questionnaires and that this larger number of alumni (369) would have reported similar mean alumnus energy (equivalent to approximately four audits per year) and cost savings equal to those of the sample of 132. This assumption increases energy and cost savings estimates reported by the follow-up questionnaires between a factor of 2.5 and 2.7, depending on the year of the estimates. This conservative approach assumes that the remaining 74% of IAC alumni do not contribute to program impact.

ES.4.3 Website Methodology

The data collected from the Website questionnaire were reviewed, first, to determine whether the respondents were U.S. residents and, second, for validity. It was clear from the domain names that several respondents were from foreign countries. The savings reported by these foreign respondents were not included in the results reported in Table ES.1. In addition, three domestic respondents reported very high energy and cost savings. Each respondent was contacted; only one set of savings results could be validated for inclusion in Table ES.1. The energy and cost savings estimates provided by respondents during the 96-day period are not adjusted in any further way. This is a conservative assumption which represents uncertainties about the number of people who may use IAC Website information each year to save energy and costs.

ES.5. IAC IMPACTS UPON INDUSTRIAL ENERGY-EFFICIENCY DECISION MAKING

This project also developed a model to describe an industrial firm's energy-efficiency decision making over time. The model posits seven stages, which range from "no energy-savings decision making" to "EE program implementation" to "steady-state EE decision making" (see Fig. ES.1). It is hypothesized that government EE programs, such as the IAC Program, can accelerate the speed with which industrial firms move through the model's seven stages. In addition to the data collected and described in Sects. ES.2 and ES.3, data were collected about firms' stages in the model before and after receiving one of three IAC benefits: a direct energy assessment, the employment of a student alumnus of the IAC Program, or use of EE information from an IAC Website.

Table ES.2 presents results about shifts in life cycle stages in EE decision making for the client firms, alumni employers, and IAC Website-using organizations. Overall, all three groups can be seen to be moving further along the EE decision-making life cycle after the IAC Program intervention. For example, only 5% of the clients were categorized in the last three stages of the life cycle—routinization, inculturation, or steady state—before the assessment whereas 62% were so categorized after the assessment. As seen above, the changes identified in the alumni employer organizations were less stark but also substantial, with 30% of the alumni employers falling into the last three stages of the life cycle before hiring an alumnus versus 56% after hiring an alumnus. The Website-using organizations also exhibited positive movement along the life cycle but at a much smaller magnitude. The changes for clients and alumni employers were highly statistically significant; the results for the Website-using organizations were much less statistically significant.

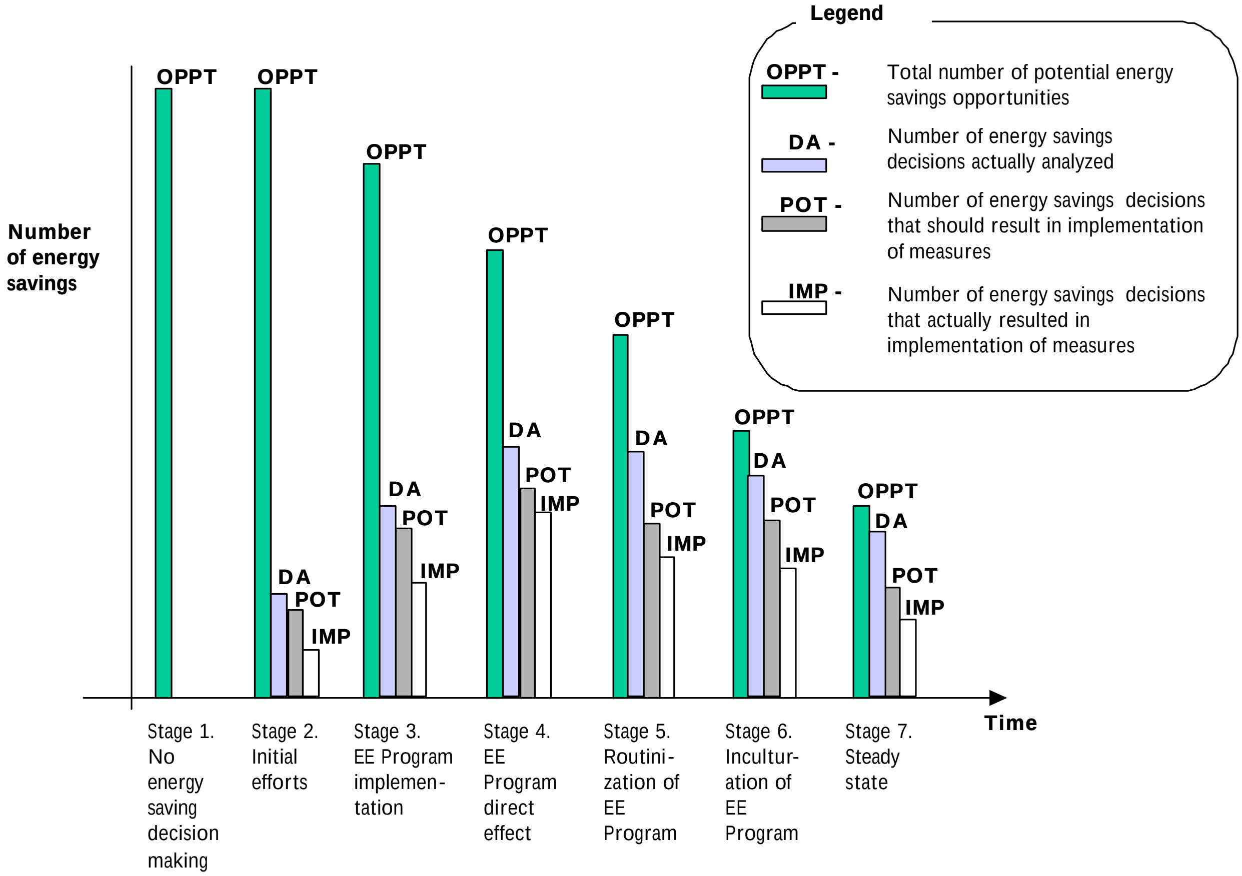

Fig. ES.1. Life cycle model of participant firms' energy-efficiency (EE) decision making.

Table ES.2. Stages in the energy-efficiency (EE) decision-making life cycle before and after IAC Program interventions[a]

Study	IAC Intervention	No EE Decision Making = 1	Initial Efforts = 2	EE Program Implementation = 3	EE Program Direct Effect = 4	Routinization of EE Program = 5	Inculturation of EE Program = 6	Steady State = 7	Number	Mean	Standard Deviation	T-Test Significance
Client	Before	2	43	38	12	0	5	0	40	3.5	2.0	0.001
	After	0	3	18	18	5	49	8	39	4.6	1.8	
Alumni	Before	15	23	29	2	2	12	16	82	3.5	2.1	0.001
	After	1	16	19	8	8	29	19	89	4.7	1.9	
Web	Before	8	12	16	16	8	16	29	25	4.5	2.0	0.15
	After	5	5	18	9	0	41	23	22	5.1	1.8	

[a]Numbers are percentages except for T-test significance

ES.6. CONCLUSIONS AND RECOMMENDATIONS

The results indicate that the IAC Program can be credited with saving an appreciable amount of energy and costs. Direct energy and cost savings associated with assessments are higher than previously thought. Less directly, employers hiring IAC student alumni and organizations using IAC Websites are also receiving significant energy and cost savings. Additionally, there are strong indications that the three IAC Program elements are capable of affecting long-term and permanent changes in industrial energy-efficiency decision making. Details of this study may be found in the report titled "Industrial Assessment Center Program Impact Evaluation," by Martin et al. (1999).

The following recommendations pertain both to improving future evaluations of IAC Program energy and cost savings and to improving the program itself:

- increase number of clients responding to the long-term (greater than 2 years) follow-up questionnaire to better address savings persistence and to reduce the standard errors of the energy and cost saving estimates;
- continuous collection of client and alumni data, with annual analyses of impacts;
- continually maintain the Website users questionnaire, as this is a very cost efficient way to collect data;
- implement usage monitoring software for IAC Websites;
- conduct exit interviews with alumni on a routine basis and develop and maintain an alumni follow-up questionnaire on the Web;
- implement procedures that promote continuous interactions with clients and alumni over time;
- estimate energy and cost savings associated with moving from one stage to the next in the EE decision-making model illustrated in Fig. ES.1.;
- work to better understand which IAC and OIT products are most appropriate for firms at different stages of the model illustrated in Fig. ES.1 and develop new program elements (e.g., executive training courses) as appropriate; and
- conduct research to better understand how firms currently make EE decisions and identify IAC and OIT elements that can help overcome deficiencies in this type of decision making—e.g., specifically evaluate why recommended measures with paybacks of 2 years have implementation rates of less than 50%.

1. INTRODUCTION

This report presents the results of an evaluation of the impacts of the Industrial Assessment Center (IAC) Program, which is run by the Office of Industrial Technologies (OIT), U.S. Department of Energy (DOE). The IAC Program provides small and medium-sized manufacturers with energy, waste, and productivity assessments. These assessments are prepared by teams of engineering students and faculty located at 30 colleges and universities across the country.

The primary goal of this project was to further evaluate energy and cost savings benefits attributable to the assessments performed under the IAC Program. Other goals were to assess the impacts of various IAC Program activities upon energy efficiency (EE) decision making and to learn more about the impacts of IAC student alumni and users of IAC Program Websites. In combination, these results will assist DOE in developing program metrics for the IAC Program that will help DOE meet the requirements of the Government Performance and Results Act of 1993 (GPRA) as well as provide important information to IAC Program Management.

Evaluating the benefits of the IAC Program presented several challenges. This is because the benefits of the program can extend far beyond the preparation and delivery of assessments to IAC client firms and the energy and cost savings that may result when the firms implement recommendations contained in the assessments. For example, firms may replicate recommendations in parts of the plant other than the one that was the focus of the assessment or may even replicate the recommendations in other plants. Students trained to do industrial assessments may now hold jobs where they are responsible for conducting energy assessments and otherwise influencing EE decision making. Finally, information from IAC Websites may be used by organizations to spur their own EE investments.

Presently, the IAC Program uses a well-established database (Muller, Barnish, and Kasten 1998) to track savings resulting from implemented assessment recommendations. However, to assess the other types of benefits mentioned above, additional data were needed. Specifically, new evaluation approaches to measure these additional benefits and to report the IAC Program's performance results more comprehensively were required. This report presents those methods and the results of follow-up questionnaires from former IAC clients, IAC alumni, and users of IAC Websites conducted to measure these additional benefits.

Section 2 describes the two major evaluation approaches used in this study. The first approach is called the comprehensive benefits ratio (CBR) model. It is proposed that this ratio be used to adjust estimated assessment savings up or down to account for the additional types of benefits mentioned above. The second approach centers on a multistage model of EE decision making. It is hypothesized that over time firms move from a state of no EE decision making to a stage where such decision making is part of the culture. It is also hypothesized that the IAC Program helps to move firms along through the stages of this model. Both approaches are used to guide the data collection efforts.

Sections 3, 4, and 5 describe the methods used to collect data from IAC clients, alumni, and Website users, respectively. These sections also provide results related to energy and cost savings and EE decision making. Section 6 presents aggregated results in this area. The report concludes with a series of observations and recommendations. Appendices A, B, and C contain the questionnaires and supplemental statistics for the client assessments, alumni, and Website users, respectively.

2. APPROACHES FOR IMPACT EVALUATION

This section presents the theoretical basis for the evaluation of IAC client impacts and decision making. Section 2.1 describes the CBR model; Sect. 2.2 discusses the industrial EE decision-making model. The CBR model was introduced in Martin et al. (1999), whereas the decision-making model is introduced here.

2.1 THE COMPREHENSIVE BENEFITS RATE MODEL

The notion of comprehensive benefits was discussed in Martin et al. (1999) as an extension of the idea of realization rate. A realization rate (RR) is the ratio of measured annual savings to original audit-predicted annual savings for implemented savings measures. For energy savings measures, an RR is determined through the collection and analysis of data on the amount of change that is actually realized in measured energy consumption. RRs that are close to 1.0 confirm the accuracy of the engineering estimates. Martin et al. (1999) show by comparison with similar programs that IAC RRs are likely to be reasonably close to 1.0.

A CBR is the ratio of all annual savings attributable to an implemented measure to the original estimate of annual savings for the measure. A CBR is analogous to a corresponding RR, but typically encompasses more and is larger than the RR. (The denominators of the two ratios are the same, but the CBR may have a larger numerator.) Annual savings due to external and internal replication, long-term implementation, and spin-off effects from heightened awareness among clients of energy, waste, and productivity issues are among the examples of additional savings that would be encompassed in a CBR for IAC assessment recommendations (ARs). When the corresponding RR is close to 1.0, the CBR is the sum of 1.0 and the ratio of these additional savings to the original savings estimate. In that case, estimating the CBR involves estimating the additional annual savings and verifying the extent to which measures assumed to be implemented, in fact, are.

A pilot study for estimating CBRs is discussed in Martin et al. (1999) and in Sect. 3 of this report. The main goals of the pilot study were (1) determining the feasibility of estimating CBRs by conducting follow-up interviews of IAC clients, (2) estimating standard errors of CBR estimates, and (3) devising a stratification scheme for a fully developed client study.[1] Assuming that a fully developed client study is feasible, estimates of standard errors of CBR estimates are needed to estimate sample sizes necessary for adequate statistical precision in the fully developed study.

[1]Stratification is the division of a population into subgroups. For example, IAC clients could be stratified by industry type (standard industry code [SIC]) or plant size. In stratified random sampling, elements are sampled randomly within strata. This often results in increased statistical precision of the overall estimates because intra-strata variability is often much smaller than overall variability.

Investigation of stratification schemes for ensuring adequate representation of strata of interest (e.g., standard industry codes [SICs]) and reducing sampling error is standard statistical protocol. Thus, for each stratum of interest, we seek to estimate a CBR, which can be estimated by determining the actual savings for a sample of subjects from the stratum, and by computing the ratio of that total to the total of the corresponding original assessment savings estimates:

$$\text{CBR for Stratum} = \frac{\text{Total Actual Annual Savings for Stratum}}{\text{Total of Original Annual Savings Estimates for Stratum}} \approx 1.0. \qquad \text{(Eq. 2.1)}$$

Persistence of IAC savings and verification of persistence, however, have become issues of central interest in the accounting of IAC Program benefits. Annual savings (and CBRs) are likely, on the average, to vary with time subsequent to the assessment, probably first increasing—as initial savings are realized and replication and implementation of previously unimplemented ARs occur—and then decreasing as the original ARs become obsolete. Estimating persistence of savings requires that sampling be over multiple years. Because each client (assessment) represents one year (or fiscal year [FY]), constraints on feasible sample sizes suggest that the best candidate for sample stratification is the FY assessment. This is discussed in Sect. 3. Thus “Stratum” in Eq. 2.1 will become FY.

When the stratification variable is FY, the adjusted lifetime savings estimate for individual clients is determined by summing over FYs subsequent to the client’s assessment up to some last year *L*:

$$\text{Assessment Lifetime Savings Estimate} = \sum_{Y=1}^{L} CBR(Y) \times (\text{Original Ann. Savings Estimate}). \qquad \text{(Eq. 2.2)}$$

The year *L* must be inferred either by assumption or from statistical evidence. In Eq. 2.2, there is a separate CBR for each fiscal year, *Y* savings are incurred for each FY after the assessment, and the CBR changes with *Y* to reflect changes in the actual annual savings. There is no $Y = 0$ term in Eq. 2.2, because, to account for a time lag until implementation, the model assumes that savings begin to accrue during the first FY after the assessment. This is an approximation that could be refined by using implementation dates in the accounting scheme. Recorded implementation dates are often approximations themselves, however, and that refinement is not pursued here.

Equation 2.2 assumes time invariance that CBRs depend on the number of years since the assessment but do not otherwise depend on time. In practice, *CBR(Y)* can be estimated by stratifying by FY, interviewing clients, estimating CBRs for assessments performed in each FY, and taking

$$Y = \text{Follow-up } FY - \text{Assessment } FY. \qquad \text{(Eq. 2.3)}$$

This conversion from FY to Y is illustrated in Sect. 6. Under this invariance, savings depend on time only through the difference *Y*, not the actual FY of the assessment or follow-up. But that assumption can also be checked in future studies.

Note that Eq. 2.2 differs from the corresponding equation in Martin et al. (1999, Sect. 2.1), where CBRs were specific to strata other than time strata (e.g., SICs); and separate CBRs were not considered for separate FYs. In Eq. 2.1, CBRs are FY-specific, because of limitations on sample sizes, this approach renders impractical stratification by additional variables such as SIC (see Sect. 3.5).

As with RRs, comprehensive saving estimates for clients can be tallied to produce savings estimates for individual strata and overall. This can be done for energy, waste, productivity, and overall dollar savings, energy savings, etc. Equation 2.1 refers to all benefit types comprehensively, but it could be rewritten to refer to specific benefit types—that is, internal and external replication, implementation of previously unimplemented ARs, etc. This kind of estimate, which is known as a ratio estimate, is discussed in textbooks on sample survey methodology (for example, Cochran 1977). Although the underlying sampled ratios may be quite variable, standard errors for the estimates can be calculated, to provide an indication of the approximate accuracy of the estimates and thus an assessment of the adequacy of the evaluation approach. These calculations are illustrated in Sects. 3 and 6.

2.2 THE INDUSTRIAL ENERGY EFFICIENCY DECISION-MAKING MODEL

A second approach to evaluating the effectiveness of the IAC Program draws upon ideas found in the literature on evolutionary economics and decision analysis to build a life cycle model of changes in energy savings decision making over time. The IAC Program, through its audits, alumni, and World Wide Web resources, can influence the pace of change of energy savings in industry and elsewhere as portrayed by the life cycle model.

Evolutionary economics has its roots in the work of Schumpeter (1911, 1943), who is famous for his observation that economic development relies on the act of creative destruction (where new ideas, technologies, and products overwhelm and replace the old). One main assertion of evolutionary economics is that technical change is an important, if not the most important, engine of economic development (Kwasnicki 1996; Metcalfe 1998; Nelson and Winter 1982; Saviotti 1996). Solow (1957) is credited with moving the field substantially forward with his path-breaking research in measuring the contribution of investment in technological change to economic development. In recent decades, an effective relationship between the research community and industry has spurred technical change (Metcalfe 1998). In fact, a robust technological system needs to be in place to support technical change and economic development. This system needs to encompass an extensive institutional infrastructure for the purpose of generating, diffusing, and utilizing technical knowledge (Carlsson and Stankiewicz 1991; Carlsson 1992). Nelson (1987) argues that the institutions responsible for the generation of key types of knowledge are among the most important in determining the performance of a country as an innovator. Several authors refer to this system as a national system of innovation (Saviotti 1996).

It is appropriate to understand the IAC Program as part of the U.S. national system of innovation. It is an institutionalized function of the national government designed to diffuse technical knowledge related to saving energy and reducing costs of small and medium-sized plants in the U.S. industrial sector. It does this directly through its energy audits for clients and through its Web resources. It does this indirectly by training students in university settings in industrial energy processes and energy-saving methods and procedures, who then act to diffuse this knowledge throughout the economy. Thus, through the diffusion of technological knowledge, the IAC Program contributes to economic development in the United States.

To measure the success of the IAC Program in diffusing technical knowledge, one first needs to count the number of audits conducted, the number of students trained, and the number of firms benefitting from Web resources. In addition, it is necessary to attempt to measure actions resulting from the availability of this knowledge. Diffusion of knowledge is useful only if such knowledge results in decisions and behaviors that would not have happened otherwise or would have happened much later in time. The balance of this section describes a life cycle model that is used to measure the impact of IAC knowledge diffusion efforts upon participants' energy savings decision making.

Before we discuss the life cycle model, we must first define more clearly what is meant by decision making and diffusion. *Decision making* refers to the behavior of firms with regard to choosing whether or not to implement energy savings measures. Simon (1986, p.38) states that "the dynamics of the economic system depends critically on just how economic agents go about making their decisions." Knowledge needed for sound economic decision making is always of a dispersed nature (Hayek 1945). This means that different decision makers (i.e., firms) may have more or less knowledge about energy savings opportunities, costs, and benefits. Thus, contrary to typical assumptions in economics about the rational man, who has perfect knowledge, firms virtually always lack knowledge. Simon (1979) uses the term *bounded rationality* to describe this situation. One key of the IAC Program, then, is to bring increased knowledge—through audit results, in the persona of IAC alumni, and over the Web—to firms to improve their energy savings decision making.

Diffusion is a term used to describe how well this knowledge spreads throughout the economy. Diffusion research has focused primarily on how new technologies spread throughout the economy. The basic model holds that there are three types of technology adopters: innovators, middle-of-the-roaders, and laggards. Over time, a small number of innovators first adopt a new technology, then a very large number of middle-of-the-roaders, and then after an extended period of time, if ever, the laggards. Seminal work by Griliches (1957) and Mansfield (1969) has shown that diffusion curves take on logistic shapes.

IAC audits, alumni, and Web resources are the agents of diffusion for the IAC Program. What they carry are not new technologies but new ideas, concepts, processes, methods, and uses for technology aimed at saving energy. Innovators would be the first to volunteer for energy audits, hire alumni, and make use of Web resources. Middle-of-the-roaders would follow. Over time, the IAC agents of diffusion would diffuse even further within firms and to other firms not directly touched by the IAC Program.

Also over time, one can argue that the energy-decision-making habits of innovators would change, moving from a state of no energy savings decision making to a steady state of continual, vigilant, and cost-effective energy savings decision making that is routinized and part of the firm's culture. As more firms join innovators in this process, one can envision all of industry as existing somewhere in between the two states of making no energy savings decisions and making optimal energy savings decisions. The term *energy savings life cycle decision making* is used herein to refer to this process over time and to describe the decision making of individual firms or the aggregate decision making of participants. Figure 2.1 presents a life cycle model that has seven stages. It will explained from the viewpoint of an individual firm.

The first stage of the model, illustrated by the leftmost bar in Fig. 2.1, is the No Energy Saving Decision Making stage. At this point in the life cycle of the firm's energy savings decision making, the firm has no conceptualization of any energy savings opportunities. In other words, no energy savings decisions have yet been created in the minds of any of the firm's employees (Kwasnicki 1996). This is in spite of the fact that there are actually a large number of opportunities available to the firm (signified by the height of the OPPT bar).

The second stage of the model, Initial Efforts, indicates that some diffusion of knowledge has occurred. The firm now undertakes to analyze a small number of energy savings decisions, signified by the height of the bar labeled DA. It must be noted that undertaking a decision does not mean that a firm will actually choose a decision alternative that results in the implementation of energy savings measures. For example, the firm may have a lack of information about the benefits of implementing energy savings measures (e.g., the payback periods) and only see the up-front costs. In these situations, firms will make bad decisions which more often than not will result in fewer implementations of

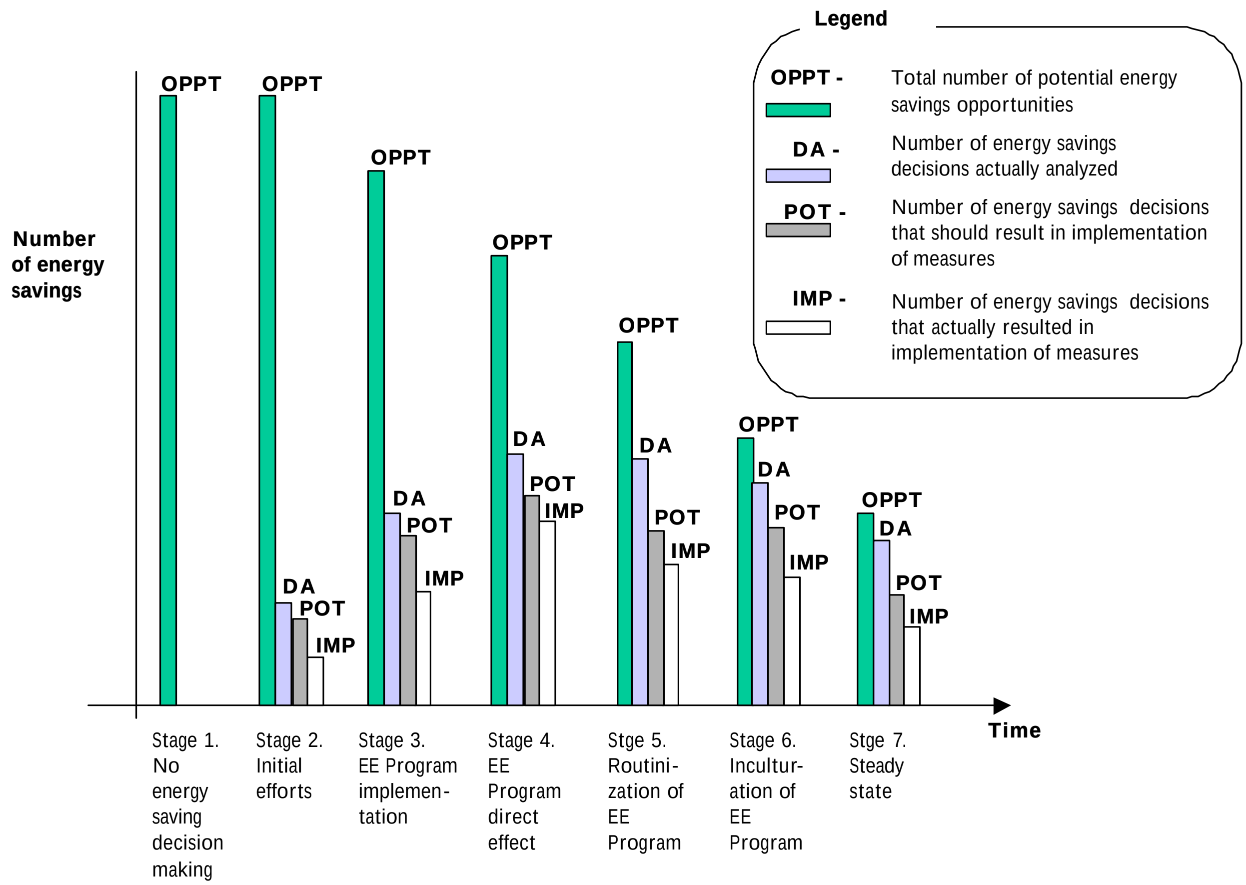

Fig. 2.1. Life cycle model of participant firm's energy efficiency (EE) decision making.

energy savings measures. On the other hand, even well-researched decisions may not result in the implementation of measures. This is because not all measures are appropriate for all firms. Thus, the height of the POT bar represents the number of decision analyses undertaken by the firm that should result in the implementation of energy savings measures (DA minus POT represents the number of decisions that should not result in the implementation of measures). The height of the IMP bar represents the actual number of implemented decisions. POT minus IMP represents the level of bad decision making by the firm.

The third stage, Program Implementation, indicates that the firm has implemented a nascent energy savings program. The firm is actively considering more energy savings decisions (note the rise in bar DA), which according to Winter (1984) "involves the manipulation and recombination of the actual technological and organizational ideas and skills associated with a particular economic context." Some headway has been made in reducing the backlog of energy savings opportunities (note the drop in height of bar OPPT). The firm is still assessing the most obviously beneficial energy savings opportunities, so most decisions ought to lead to the implementation of measures (as signified by the small difference between DA and POT). The firm is making better decisions, too (as signified by the relatively smaller difference between POT and IMP).

The fourth and fifth stages, Program Success and Routinization, indicate that energy savings knowledge has become part of the firm's knowledge base, which Metcalfe and Gibbons (1989) define as the collective knowledge used by a firm/organization to underpin its production activity. Energy savings decision making becomes routine. Nelson and Winter (1982) define *routines* as "regular and predictable behavioral patterns of firms." Searching for new energy savings opportunities may result in changes to other routines followed by the firm, but the process of searching, decision making, and measure implementation is now routine. One can argue that these two stages witness much learning by doing, which is a rational response to imperfect knowledge (David 1975).

By the Inculturation stage, energy savings decision making becomes part of the culture, to where its value is unquestioned and its pursuit is second nature. Theoretically, firms could eventually reach the seventh stage, which is labeled Steady State. In this stage, the firm is aware of almost all energy savings opportunities open to it. Although the number of opportunities have declined over time as they have been pursued (note the fall over time in the height of the OPPT bar), each year new opportunities may arise as new technologies are created, new processes tested, etc. Thus, in the steady-state stage, the firm continuously scans for new opportunities. However, it must be made clear that the firm may not have resources every year to analyze the costs and benefits of all energy savings opportunities available to it. Thus, one could expect there to be some difference between OPPT and DA. Also, because most of the most obviously beneficial measures were implemented by the firm in earlier stages, one could expect a low percentage, say around 50%, of all energy savings decisions analyzed to result in the implementation of energy savings measures. Thus, the relative difference between DA and POT appears large but is intuitively defensible. On the other hand, given years of experience and a highly developed knowledge base, the firm does not now make many bad energy savings decisions. Thus, the difference between POT and IMP is small. Once a firm reaches the steady-state stage, the only events that could force it back in the life cycle are withdrawal of commitment to energy saving or a discontinuous change in its energy-consuming technology and/or processes, which would make its current knowledge base obsolete.

It can be argued that a major purpose of the IAC Program is to accelerate the life cycle process described above. In other words, the goal of the program is to reduce the time needed to move from the left-hand side of Fig. 2.1 to the right-hand side, to move from complete ignorance about energy savings to an optimal steady state. When all firms are considering all potential energy savings options and making the best decisions, then "victory is complete." Of course, victory may never be complete because new firms that may need energy savings assistance are always entering the business landscape and new technologies are always being developed requiring new knowledge about energy savings.

The three avenues by which the IAC Program can influence the life cycle process—through its assessments, its alumni, and the Web-based distribution of information—impact the model in two ways:

- by bringing to the consciousness of firms potential energy savings decisions that are theirs to make (thus reducing the gap between OPPT and DA in the life cycle process illustrated by Fig. 2.1), and
- by providing to firms better information about the benefits and costs of implementing energy savings measures (thus reducing the gap between POT and IMP in the life cycle process illustrated by Fig. 2.1).

If we use an input-output-outcome view of the IAC Program, the inputs are funding; the outputs are audits, trained alumni and Websites; and the outcomes are more and better energy savings decisions and ultimately energy savings. The model suggests that IAC Program audits, alumni, and Web-based distributed information can have a permanent and cumulative positive impact upon industrial energy saving in the United States.

Sections 3.4, 4.4 and 5.4 explore this model using data collected through the questionnaires of clients, alumni, and Web users. In each questionnaire, a set of questions was asked about the frequency with which energy savings opportunities were identified and energy savings measures were implemented before and after an IAC Program intervention (i.e., an assessment, hiring an IAC Program alumnus, or using an IAC Program Website). These answers were synthesized to provide some insight into the firm's stages in the life cycle model before and after the intervention. For example, had an alumnus reported that his employer never identified or implemented energy savings opportunities, then that employer would fall into the No Energy Saving Decision-Making category. Had an alumna reported that her employer very frequently identified and implemented energy savings opportunities, then that employer would fall into the Steady-State category. All 25 combinations of the answers to identification and implementation questions were coded into one of the seven life cycle stages. The process of creating this categorization was necessarily subjective, and this entire exercise could be improved in numerous ways. However, the methodology and data are strong enough and the resulting data analysis of sufficient rigor, to allow us to make some preliminary conclusions.

The literature revealed one previous attempt to model industrial energy savings decision making in a manner analogous to a life cycle model. Elliott and Pye (1998) present a model to understand industrial-sector investments in energy efficiency. Their model has seven steps: (1) opportunity identification, (2) technology identification and project design, (3) financial analysis, (4) purchasing and procurement, (5) financing, (6) installation, and (7) startup and training. They argue that successful technical-assistance programs in industry need to incorporate all steps, not just one or two. Elliott and Weidenbaum (1994) document the success of New York's FlexTech program in addressing all the steps. Elliott, Pye and Nadel (1996) found that startup and training can be the most critical step in maximizing long-term savings potential. The life cycle model is similar to Elliott and Pye's model—its first stage is similar to Elliott and Pye's first step, and the decision-making process of the life cycle model encompasses at least steps 2 through 6 of the Elliott and Pye model. The life cycle model, however, presents a process that follows time and is more explicit in its decision-making structure.

Where is U.S. industry now according to the life cycle model? It is the intention of this project to help answer this question as well as shed light on how audits, alumni, and Web resources may move a firm along the life cycle. However, the literature does indicate that industry in general has moved at least beyond the first couple of stages. Industrial energy intensities have been declining since the oil price shocks of the 1970s. Schipper et al. (1997) found that manufacturing energy intensities have fallen in a sample of 10 developed countries from the early 1970s to the early 1990s. Fukasaku (1995) found that Japan has had a remarkable decline in energy intensities in its industrial sector. Thus, at the very least, firms have implemented the most obvious energy savings measures.

Both Elliott and Pye (1998) and Hollander and Schneider (1996) report, however, that the rate of decline in energy intensity in the U.S. industrial sector has slowed in recent years. Reasons for this slowdown are numerous and include declining real energy prices and reductions in expenditures on research and development (R&D) by both the U.S. government and the private sector. Energy efficiency advocates argue that there are numerous additional energy savings opportunities available to industry so that the slow down cannot be attributed to a lack of opportunities. Elliott (1994) reports that companies like Dow Chemical found that the more they look for EE opportunities, the more they find, and that these opportunities often have non-energy benefits that far exceed energy savings. This evidence suggests that industry in general may fall somewhere between stage 3, Program Implementation, and stage 4, Program Success, in the life cycle model, leaving much to be done. Indeed, the results reported in the following sections for IAC clients, firms that employ IAC alumni, and organizations that made use of IAC Web-based information support this observation.

3. CLIENT IMPACT STUDY

A pilot follow-up study of IAC clients was conducted to test and develop a method for examining the impacts of measure replication, long-term implementation, and savings persistence on assessment-generated energy and cost savings. Where as the previous literature review (Martin et al. 1999) identified several small-scale or anecdotal IAC client studies that documented internal and external replication as well as long-term implementation of recommended IAC measures, none of these studies attempted to quantify the savings impacts. One study (Wilfert, Kinzey, and Kaae 1991) did report a savings persistence that ranged from 4 to 7 years.

The ultimate goal of the client impact study is to provide stronger, scientifically sampled data about replication, long-term implementation, and savings persistence. The primary goal of the pilot study was to determine if acquiring such data was feasible and to estimate the sample sizes necessary to ensure reasonable statistical confidence. Secondary goals of the study included examining the impact of interaction with the IAC on the clients' decision-making skills with respect to implementation of EE and conservation measures; soliciting performance evaluations of energy, waste and productivity services provided by the IAC; and determining a stratification scheme for a full-scale study (see Sect. 2.1).

This discussion is divided into 4 sections, with a supporting appendix. Section 3.1 details the design of the follow-up questionnaire. Section 3.2 addresses the approach to statistical sampling of IAC clients. Section 3.3 discusses the results pertaining to energy and cost savings. Section 3.4 discusses the perceived impacts of the IAC on client EE decision-making skills. Preliminary conclusions and recommendations for the client study are presented in Sect. 3.5. Appendix A contains the original questionnaire (A.1), summary tables of responses to miscellaneous questions including those on client satisfaction with IAC services (A.2), summary figures and table on the characteristics of participating clients (A.3), summary tables of assessment savings for participating clients (A.4), and various plots used for data quality analysis (A.5).

3.1 QUESTIONNAIRE DESIGN

The pilot client questionnaire Appendix A.1—designed primarily to collect data to quantify savings impacts from replication, long-term implementation, and persistence—asked clients to

- confirm implementation status and energy and cost savings of IAC recommendations (questions 1 and 2);
- identify implemented measures replicated internal and/or external to the original plant (questions 3 and 4); and
- identify additional energy and/or cost saving actions implemented following their IAC assessment (question 5).

To support the secondary goals of studying the IAC impact on decision-making skills and client satisfaction, clients were asked to

- evaluate the quality of energy, waste, and productivity services provided by the IAC (questions 6 through 8); and
- comment on the impact of IAC interaction on energy-related decision making (questions 9 and 10).

During the development of the questionnaire several iterations were required to ensure that the questions were clear, unambiguous, and captured the necessary information. The questionnaire was tested with two, then five, respondents. Only minor changes in question phrasing were required.

Forty-two previous IAC clients, selected randomly, participated in the study (see Sect. 3.2 for details). Initial client contact was established by the IAC directors, who were asked to brief the clients about the study and to assure them of a guarantee of confidentiality. The centers identified the person at the site who could participate in the study. Centers also gathered the original assessment reports, which were necessary to administer the questionnaire as well as to aid subsequent analysis of data.

The next contact with the clients consisted of introductions of the interviewer and the project. The interviewer confirmed that the contact was the appropriate individual at the plant with whom to speak, determined whether the contact had access to the IAC report, and scheduled an appointment for the interview. For about half of the clients, the staff faxed the executive summary, table of contents, and recommendations sections of the respective report. An average of 3.6 calls were required to contact the client prior to the actual interview.

Telephone interviews of each participating client lasted between 15 and 30 minutes. In some cases, more than one person at the plant participated. In three cases, the interview was conducted in two parts because clients wanted to provide detailed, verified cost and energy savings information that they did not have available immediately. Data were recorded using hand-written notes on the questionnaire form that were later entered into an Excel database and checked for accuracy.

3.2 SAMPLING DESIGN

The goal of the pilot study was to obtain preliminary data for about 50 IAC clients (see Martin et al. 1999, Sect. 3). The data will be used to compute preliminary estimates of quantities of interest, particularly benefit rates—that is, ratios of questionnaire-reported estimates to original IAC savings estimates. The exact number of clients sampled in the pilot study is not critical because the pilot data are in fact to be used to estimate sample sizes necessary for a future full-scale study. These required sample sizes can be accomplished by computation of standard errors of the benefit rates or other estimates of interest (see Sect. 3.3).

Random sampling was used to identify the 42 clients who agreed to participate in the study. These 42 clients were from 102 clients (i.e., assessments) selected randomly, subject to the restrictions that their IAC database (Muller, Barnish, and Kasten 1998) entries include a recorded implementation interview date earlier than January 1, 1998, and that the database indicates that the client either had implemented at least one AR, or was either considering or planning on implementing at least one AR as discussed by Martin et al. (1999).

The requirement that there was a recorded interview date prior to January 1, 1998, ensured that a reasonably long time had elapsed since the assessment and also eliminated assessments without an interview date (for which database entries were thus otherwise suspicious). As the interview date variable was not recorded for assessments prior to FY 1992, this restriction also eliminated those assessments. Although clients from fiscal years prior to FY 1992 are of interest, the pilot study sample size is too small to admit reasonable sampling of more years (e.g., FY 1988–97). Furthermore, more recent assessments would most likely lead to smaller nonresponse rates and better client recall. Thus the interview-date restriction was also used to exclude assessments prior to FY 1992 (as well as some FY 1992 assessments).

The restriction to assessments with at least one considered, planned, or implemented AR was made to avoid spending time following up assessments that seemed unlikely to yield additional savings information. Excluding them from the target population did not affect the totals of original estimates multiplied by benefit rate estimates (see Sect. 3.3.2), because the original, implemented savings estimates for these assessments were zero anyway.

The sampling restrictions shown in Table 3.1 resulted in defined target population sizes. Clients were sampled randomly from the defined population without regard to the assessment FY. Directors were asked to establish initial contact with the 102 sampled clients and to determine the clients' willingness to participate. Directors categorized the clients response using one of the following participation codes: 1—client will participate; 2—client refuses participation; 3—center was unable to contact client; 4—client plant no longer exists; 5—original contact no longer available and/or client knowledge or memory of assessment is weak; 6—center no longer exists. From the first 102 sampled clients (from 21 assessment centers), we identified 48 clients who initially said they would be willing to participate in the pilot study. The breakdown of client participation codes is found in Table 3.2. Of 48 clients identified as willing participants, 6 subsequently declined to participate when later contacted.

Table 3.1. IAC database and pilot study target population sizes by FY

FY	From IAC database	Recorded interview date before 1/1/98	Study target: interview date before 1/1/98 and at least one considered, planned, or implemented AR
1992	531	122	105
1993	585	530	481
1994	776	760	703
1995	879	874	791
1996	867	859	776
1997	720	108	98
Total	4,358	3,253	2,954

Table 3.2. Distribution of participation codes for randomly selected clients

Participation Code	Number of clients
1 - Client will participate	48
2 - Client refuses participation	17
3 - Center was unable to contact client	17
4 - Client Plant no longer exists	6
5 - Original contact no longer available and/or client knowledge or memory of assessment is weak	12
6 - Center no longer exists	2
Total	102

Thus, from the random sample of 102 clients, 42 participated in the pilot study. The nonresponse rate is therefore 60/102, or 59%. Although this is a high rate of nonresponse, no attempt was made to follow up the nonresponders. Because the initial client contacts were made through center directors, and because client confidentiality was initially established by the centers, further contact of the nonresponders by ORNL was not practical or appropriate. On the other hand, of the 102 queried clients, only 6 denials (6%) were the result of plant closures, and only 17 (17%) were outright refusals. The remainder of the nonresponse was for reasons such as failure to contact the client, or because the IAC no longer exists, reasons more likely to be unrelated to the implementation status of ARs. As a rough approximation, then, it is reasonable to ignore the nonresponse.

3.3 ENERGY AND COST SAVINGS RESULTS

The raw data spreadsheet, amended to ensure confidentiality for the pilot client study, is available upon request from the ORNL authors. Appendix A.4 contains a summary of savings, summed to the assessment level, for (1) previously implemented ARs, (2) previously unimplemented ARs, (3) internally replicated ARs, (4) externally replicated ARs, and (5) miscellaneous savings. The miscellaneous category represents spinoff savings based on verbal or undocumented recommendations from the centers or else savings that were essentially replications but were difficult to identify with a particular AR.

Data quality checks are discussed in Sect. 3.3.1. In Sect. 3.3.2, the savings summarized in Appendix A.4 are further summarized and related to original IAC savings estimates reported by the IAC database. In Sect. 3.3.3, shifts in implementation between previously implemented and previously unimplemented (as indicated in the IAC database) ARs are also discussed.

3.3.1 Data Quality Assurance

Data quality was ensured first by careful data entry and checking. Then the initial client responses were reviewed, and where necessary, engineering estimates of savings were either revised or developed to support client statements quantitatively. These calculations were performed by an engineer and incorporated with site and recommendation data from the original assessment reports.

Revisions are documented in the database. Finally, results were checked through graphical and statistical analyses. In particular, questionnaire results were compared with original results from the IAC database. Various plots comparing pilot study and original assessment data are presented in Appendix A.5. No data were discarded or revised, however, on the basis of these plots.

3.3.2 Energy and Cost Impacts

Table 3.3 lists questionnaire-reported savings along with original (baseline) savings estimates from the IAC database. CBRs (questionnaire-to-original estimated savings ratios) are also given. Results in the table are broken down by savings metric (dollar cost and source and site energy savings) and by benefit type: for previously implemented ARs, previously unimplemented ARs, internal replication, external replication, miscellaneous, and comprehensive (all benefit types). These rates can be used as multipliers for estimating actual savings of the various types from original savings estimates.

Table 3.3. Benefit totals, rates, and rate standard errors

Fiscal Year	Number Assessments	Questionnaire-Reported Savings	Original Estimated Savings	CBR	Approx. Std. Err. of Rate
Cost					
Unit: Cost ($), Benefit Type: All (Comprehensive)					
92	1	1,991.00	36,853.00	0.05	.
93	8	117,480.66	86,044.00	1.37	0.44
94	9	134,615.52	150,156.00	0.90	0.29
95	11	655,234.93	452,312.00	1.45	0.33
96	10	375,618.52	360,258.00	1.04	0.27
97	3	57,262.25	56,670.00	1.01	0.04
All	42	1,342,202.88	1,142,293.00	1.18	0.21
Unit: Cost ($), Benefit Type: Implemented (Baseline)					
92	1	1,991.00	36,853.00	0.05	.
93	8	53,736.04	86,044.00	0.62	0.14
94	9	70,710.59	150,156.00	0.47	0.09
95	11	612,698.43	452,312.00	1.35	0.38
96	10	327,933.18	360,258.00	0.91	0.30
97	3	54,234.25	56,670.00	0.96	0.03
All	42	1,121,303.49	1,142,293.00	0.98	0.25
Unit: Cost ($), Benefit Type: Previously Unimplemented					
1992	1	0.00	36,853.00	0.00	.
1993	8	51,714.62	86,044.00	0.60	0.40
1994	9	19,528.93	150,156.00	0.13	0.10
1995	11	13,215.50	452,312.00	0.03	0.02

Table 3.3 (cont.). Benefit totals, rates, and rate standard errors

Fiscal Year	Number Assessments	Questionnaire-Reported Savings	Original Estimated Savings	CBR	Approx. Std. Err. of Rate
1996	10	32,235.34	360,258.00	0.09	0.07
1997	3	3,028.00	56,670.00	0.05	0.01
All	42	119,722.39	1,142,293.00	0.10	0.05
Unit: Cost ($), Benefit Type: Internal Replication					
1992	1	0.00	36,853.00	0.00	.
1993	8	12,030.00	86,044.00	0.14	0.05
1994	9	20,110.00	150,156.00	0.13	0.13
1995	11	12,452.00	452,312.00	0.03	0.03
1996	10	0.00	360,258.00	0.00	0.00
1997	3	0.00	56,670.00	0.00	0.00
All	42	44,592.00	1,142,293.00	0.04	0.02
Unit: Cost ($), Benefit Type: External Replication					
1992	1	0.00	36,853.00	0.00	.
1993	8	0.00	86,044.00	0.00	0.00
1994	9	1,010.00	150,156.00	0.01	0.01
1995	11	16,619.00	452,312.00	0.04	0.03
1996	10	10,950.00	360,258.00	0.03	0.02
1997	3	0.00	56,670.00	0.00	0.00
All	42	28,579.00	1,142,293.00	0.03	0.01
Unit: Cost ($), Benefit Type: Miscellaneous					
1992	1	0.00	36,853.00	0.00	.
1993	8	0.00	86,044.00	0.00	0.00
1994	9	23,256.00	150,156.00	0.15	0.15
1995	11	250.00	452,312.00	0.00	0.00
1996	10	4,500.00	360,258.00	0.01	0.01
1997	3	0.00	56,670.00	0.00	0.00
All	42	28,006.00	1,142,293.00	0.02	0.02

Table 3.3 (cont.). Benefit totals, rates, and rate standard errors

Fiscal Year	Number Assessments	Questionnaire-Reported Savings	Original Estimated Savings	CBR	Approx. Std. Err. of Rate
MMBtu Site					
Unit: MMBtu-Site, Benefit Type: All (Comprehensive)					
1992	1	230.00	1,961.00	0.12	.
1993	8	8,485.75	8,650.00	0.98	0.39
1994	9	13,484.88	15,535.00	0.87	0.34
1995	11	13,320.45	12,549.00	1.06	0.09
1996	10	33,572.16	25,315.00	1.33	0.08
1997	3	1,207.00	1,074.00	1.12	0.26
All	42	70,300.24	65,084.00	1.08	0.13
Unit: MMBtu-Site, Benefit Type: Implemented (Baseline)					
1992	1	230.00	1,961.00	0.12	.
1993	8	4,190.28	8,650.00	0.48	0.15
1994	9	9,503.27	15,535.00	0.61	0.18
1995	11	11,321.15	12,549.00	0.90	0.11
1996	10	28,894.28	25,315.00	1.14	0.12
1997	3	980.00	1,074.00	0.91	0.06
All	42	55,118.98	65,084.00	0.85	0.13
Unit: MMBtu-Site, Benefit Type: Previously Unimplemented					
1992	1	0.00	1,961.00	0.00	.
1993	8	3,013.11	8,650.00	0.35	0.29
1994	9	109.30	15,535.00	0.01	0.00
1995	11	597.65	12,549.00	0.05	0.03
1996	10	976.88	25,315.00	0.04	0.04
1997	3	227.00	1,074.00	0.21	0.33
All	42	4,923.94	65,084.00	0.08	0.04
Unit: MMBtu-Site, Benefit Type: Internal Replication					
1992	1	0.00	1,961.00	0.00	.
1993	8	1,282.36	8,650.00	0.15	0.03
1994	9	(120.69)	15,535.00	-0.01	0.01
1995	11	423.70	12,549.00	0.03	0.03
1996	10	0.00	25,315.00	0.00	0.00
1997	3	0.00	1,074.00	0.00	0.00
All	42	1,585.37	65,084.00	0.02	0.02

Table 3.3 (cont.). Benefit totals, rates, and rate standard errors

Fiscal Year	Number Assessments	Questionnaire-Reported Savings	Original Estimated Savings	CBR	Approx. Std. Err. of Rate
Unit: MMBtu-Site, Benefit Type: External Replication					
1992	1	0.00	1,961.00	0.00	.
1993	8	0.00	8,650.00	0.00	0.00
1994	9	4.00	15,535.00	0.00	0.00
1995	11	957.83	12,549.00	0.08	0.07
1996	10	2,678.00	25,315.00	0.11	0.10
1997	3	0.00	1,074.00	0.00	0.00
All	42	3,639.83	65,084.00	0.06	0.04
Unit: MMBtu-Site, Benefit Type: Miscellaneous					
1992	1	0.00	1,961.00	0.00	.
1993	8	0.00	8,650.00	0.00	0.00
1994	9	3,989.00	15,535.00	0.26	0.30
1995	11	20.12	12,549.00	0.00	0.00
1996	10	1,023.00	25,315.00	0.04	0.05
1997	3	0.00	1,074.00	0.00	0.00
All	42	5,032.12	65,084.00	0.08	0.07
MMBtu Source					
Unit: MMBtu-Source, Benefit Type: All (Comprehensive)					
1992	1	694.37	9,213.25	0.08	.
1993	8	17,923.34	15,122.91	1.19	0.42
1994	9	28,520.13	30,562.42	0.93	0.36
1995	11	25,395.17	25,797.68	0.98	0.13
1996	10	78,358.85	59,837.88	1.31	0.07
1997	3	1,320.06	1,308.20	1.01	0.12
All	42	152,211.93	141,842.34	1.07	0.14
Unit: MMBtu-Source, Benefit Type: Implemented (Baseline)					
1992	1	694.37	9,213.25	0.08	.
1993	8	8,360.89	15,122.91	0.55	0.15
1994	9	16,873.54	30,562.42	0.55	0.14
1995	11	19,359.29	25,797.68	0.75	0.12
1996	10	70,643.73	59,837.88	1.18	0.12
1997	3	1,078.93	1,308.20	0.82	0.13
All	42	117,010.75	141,842.34	0.82	0.17

Table 3.3 (cont.). Benefit totals, rates, and rate standard errors

Fiscal Year	Number Assessments	Questionnaire-Reported Savings	Original Estimated Savings	CBR	Approx. Std. Err. of Rate
Unit: MMBtu-Source, Benefit Type: Previously Unimplemented					
92	1	0.00	9,213.25	0.00	.
93	8	7,083.64	15,122.91	0.47	0.35
94	9	258.81	30,562.42	0.01	0.01
95	11	1,804.31	25,797.68	0.07	0.04
96	10	3,155.14	59,837.88	0.05	0.06
97	3	241.13	1,308.20	0.18	0.24
All	42	12,543.02	141,842.34	0.09	0.05
Unit: MMBtu-Source, Benefit Type: Internal Replication					
92	1	0.00	9,213.25	0.00	.
93	8	2,478.82	15,122.91	0.16	0.05
94	9	3,346.69	30,562.42	0.11	0.10
95	11	1,279.15	25,797.68	0.05	0.04
96	10	0.00	59,837.88	0.00	0.00
97	3	0.00	1,308.20	0.00	0.00
All	42	7,104.66	141,842.34	0.05	0.03
Unit: MMBtu-Source, Benefit Type: External Replication					
92	1	0.00	9,213.25	0.00	.
93	8	0.00	15,122.91	0.00	0.00
94	9	12.08	30,562.42	0.00	0.00
95	11	2,891.69	25,797.68	0.11	0.09
96	10	3,468.33	59,837.88	0.06	0.05
97	3	0.00	1,308.20	0.00	0.00
All	42	6,372.10	141,842.34	0.04	0.02
Unit: MMBtu-Source, Benefit Type: Miscellaneous					
92	1	0.00	9,213.25	0.00	.
93	8	0.00	15,122.91	0.00	0.00
94	9	8,029.02	30,562.42	0.26	0.30
95	11	60.73	25,797.68	0.00	0.00
96	10	1,091.65	59,837.88	0.02	0.02
97	3	0.00	1,308.20	0.00	0.00
All	42	9,181.40	141,842.34	0.06	0.06

For example, the CBR for cost savings in Table 3.3 is 1.18 (over all years studied). That is, the follow-up questionnaire reported that total cost savings for all benefit types are about 18% higher than the original savings estimates. This suggests that original savings estimates should be inflated by 1.18 to account for actual savings. However this suggestion should be tempered with a consideration of statistical uncertainty (see following discussion). Note also that a realization rate (defined as actual savings over engineering estimates of savings) of perhaps 0.94 may also have to be applied to reflect departures from engineering estimates of savings in practice.[1] However, in view of much greater uncertainties in savings as a result of replication, in whether ARs are actually implemented and in statistical sampling error, it seems reasonable to assume the realization rate is 1.0. Here the realization rate is assumed to be 1.0.

Results in Table 3.3 are also broken down by FY. FY-specific results are useful, because savings rates are likely to change over time, perhaps first increasing—as savings for implemented ARs are realized (and recognized), and as replication and implementation of previously unimplemented ARs occur—and then, because of technology and process changes, the savings rates wane. Thus, when viewed over time, benefit rates are likely to be parabolic, increasing-then-decreasing.

Table 3.3 also lists standard errors for the various rate estimates. These standard errors indicate the statistical uncertainty of the rate estimates: the estimate plus or minus two standard errors is an approximate 95% confidence interval for the estimated rate; the estimate plus or minus one standard error is an approximate 68% confidence interval for the estimated rate. The standard errors tend to be fairly large because the savings rates for individual clients are variable and because the sample size in the (pilot) client study is small.[2]

If standard errors are ignored for the moment, the follow-up questionnaire reported cost savings are about 18% higher than the original savings estimates. Site and source savings are about 8 and 9% higher than the original estimates. An appreciable amount of this savings is the result of the implementation of previously unimplemented ARs: 10% for costs and 8 and 9% for site and source energy savings. Savings for previously implemented ARs decline slightly, however, by about 2% for costs and by 15 and 18% for energy savings. Internal and external replication and miscellaneous savings account collectively for increases of 9, 14, and 15%, respectively, for cost savings and site and source energy savings.

The standard errors in Table 3.3 show that the cost CBR (1.18) is accurate to about ±0.42 (i.e., plus or minus two standard errors). The site and source energy savings rates (1.08 and 1.07), which are a bit less variable, are accurate to about 0.26 and 0.28, respectively. Because sample sizes for individual years are smaller, standard errors for year-specific results are much higher. Because of the simple random sampling design of the study, these standard errors are proportional to $1/\sqrt{N}$, where N is the sample size. Thus, the standard errors would be cut in half, on average, by quadrupling the

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[1]Utility-sponsored studies focused on identifying realization rates for measures implemented by participants in industrial energy audit programs reported a majority of rates falling between 0.75 and 1.25, with 0.94 associated with a program most similar to that of the IAC (Martin et al. 1999).

[2]The formula for the standard error is given by Cochran (1977, eq. 2.47).

sample size to about $4 \times 42 = 168$. In that case, the standard error for the cost CBR would be reduced to about 0.10, and the 95% confidence interval to about ±0.21 or about 21/1.18 = 18%.

The changes in CBRs over the years examined (FY 1992–97) are illustrated in Figs. 3.1 to 3.3. The narrow error bars on the chart, which represent 95% confidence intervals, show that there is considerable statistical uncertainty. (No error bars are given for the FY 1992 bar, because a standard error was not computed for that year.) It is clear that a variety of curves could pass within the ranges of the confidence intervals. An increasing-then-decreasing (or parabolic) benefit rate cannot be ruled out, but neither can a constant benefit rate. Significance levels for a test that the CBRs are constant over time are given in the figure captions: none of the tests are significant.[3] As sample sizes increase, these tests would become more powerful, and the shape of the benefit rate curve could be estimated.

[3]These are chi-square tests computed from the comprehensive rate estimates and standard errors in Table 3.3.

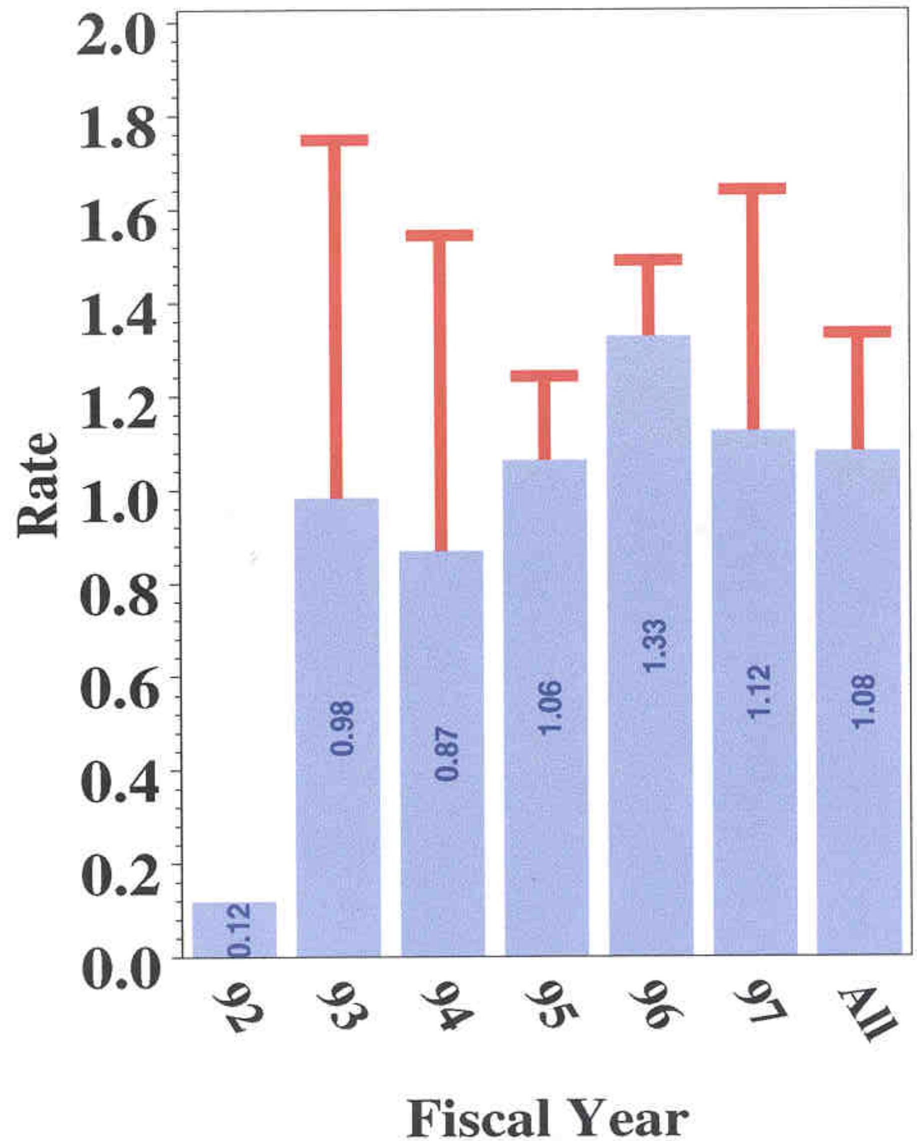

Fig. 3.2. Site energy (MMBtu) comprehensive benefit ratios. 95% confidence bounds are represented by the narrow bars; test for differences among years is not significant ($p = .21$).

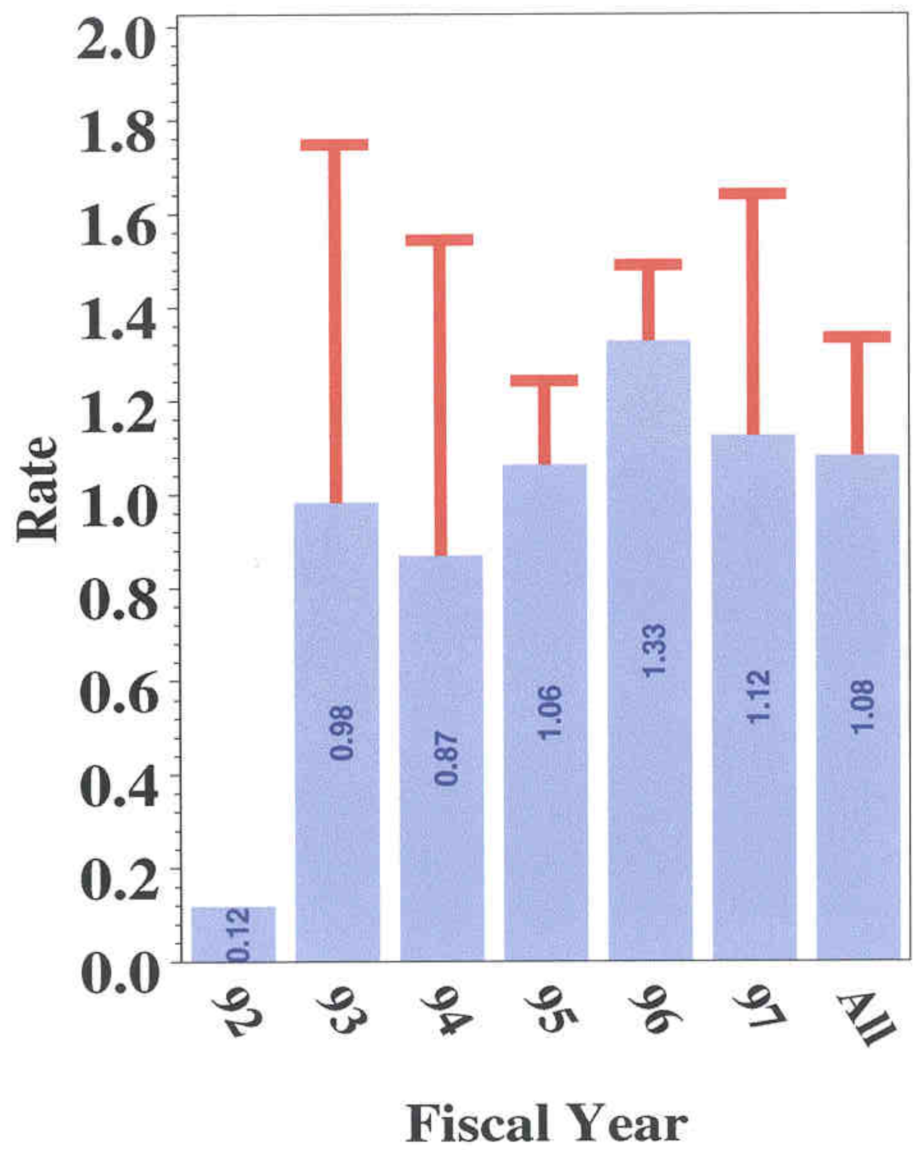

Fig. 3.2. Site energy (MMBtu) comprehensive benefit ratios. 95% confidence bounds are represented by the narrow bars; test for differences among years is not significant ($p = .21$).

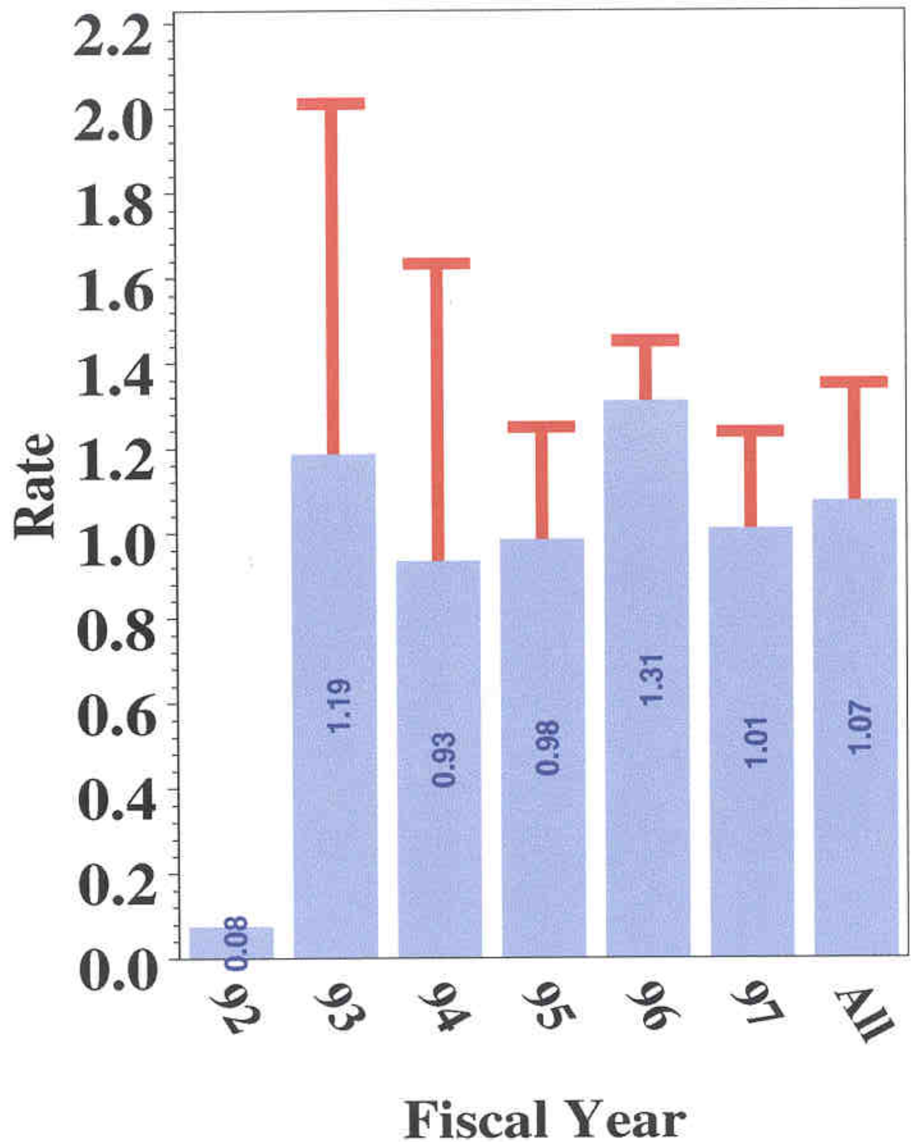

Fig. 3.3. Source energy (MMBtu) comprehensive benefit ratios. 95% confidence bounds are represented by the narrow bars; test for differences among years is not significant ($p = 0.09$).

3.3.3 Implementation Shifts

Table 3.4 is analogous to Table 3.3, but the metric is frequency of AR implementation rather than cost or energy savings. Only previously implemented or unimplemented ARs are considered here; ARs that are the result of replication or miscellaneous implementation are omitted. Implementation rates have historically been calculated by the program as the ratio of the number of implemented ARs to the total number of ARs (as reported in the IAC database). This corresponds to an original implementation rate for participating clients of 52% ± 4% (rate ± one standard error). Based on the clients' verification of implemented, partially implemented, and unimplemented ARs, the questionnaire-reported implementation rate drops to 44% ± 4%. In cases where clients indicated that recommendations were only partially implemented, credit was applied for the fraction of implementation reported. Because either cost or site energy savings could be used as a basis for computing the partial implementations, both bases are used in Table 3.4. However, the results are very similar, so the discussion here focuses on the cost basis results only.

Table 3.4 illustrates the details of this implementation shift. When only the previously implemented ARs are considered, the implementation rate (ratio of the number of previously implemented ARs reported in the study to the number of previously implemented ARs reported in the database) is 67 ± 5%. Among previously unimplemented ARs, the implementation rate (ratio of the number of previously unimplemented ARs now reported by the clients to be implemented to the number of unimplemented ARs reported in the database) is 19 ± 4%. These details indicate that while not as many ARs were implemented as were originally reported by the IAC database (67%), a portion of the ARs that were considered to be previously unimplemented were subsequently implemented (19%), resulting in a drop in total implementation rates from 52± 4% to 44± 4%.

The changes in implementation rates over the years examined (FY 1992–97) are illustrated in Figs. 3.4 and 3.5, which are analogous to Figs. 3.1 through 3.3. Again the curves do not depart significantly from the hypothesis that implementation rates are constant over time.

Table 3.4. Implementation totals, rates, and rate standard errors

Fiscal Year	Number Assess-ments	Number ARs	Question-naire-Reported Imple-menta-tions	Original Imple-menta-tions	Question-naire-Reported Imple-menta-tion Rate	Approx. Std. Err. of Survey Rate	Original Imple-menta-tion Rate	Approx. Std. Err. of Original Rate
Unit: Cost Basis, Benefit Type: All ARs (No Replications)								
92	1	6	1.5	4	0.25	.	0.67	.
93	8	51	26.1	25	0.51	0.12	0.49	0.07
94	9	66	25.8	36	0.39	0.07	0.55	0.07
95	11	76	36.8	44	0.48	0.08	0.58	0.10
96	10	69	33.5	38	0.49	0.09	0.55	0.08
97	3	35	8.8	10	0.25	0.16	0.29	0.17
All	42	303	132.4	157	0.44	0.04	0.52	0.04
Unit: Cost Basis, Benefit Type: Previously Implemented (Baseline)								
92	1	4	1.5	4	0.38	.	1.00	.
93	8	25	17.4	25	0.69	0.11	1.00	0.00
94	9	36	20.7	36	0.57	0.11	1.00	0.00
95	11	44	31.5	44	0.72	0.09	1.00	0.00
96	10	38	27.7	38	0.73	0.14	1.00	0.00
97	3	10	5.8	10	0.58	0.03	1.00	0.00
All	42	157	104.4	157	0.67	0.05	1.00	0.00
Unit: Cost Basis, Benefit Type: Previously Unimplemented								
92	1	2	0.0	0	0.00	.	0.00	.
93	8	26	8.7	0	0.33	0.11	0.00	0.00
94	9	30	5.2	0	0.17	0.07	0.00	0.00
95	11	32	5.2	0	0.16	0.05	0.00	0.00
96	10	31	5.8	0	0.19	0.05	0.00	0.00
97	3	25	3.0	0	0.12	0.14	0.00	0.00
All	42	146	27.9	0	0.19	0.04	0.00	0.00

Table 3.4 (cont.). Implementation totals, rates, and rate standard errors

Fiscal Year	Number Assess-ments	Number ARs	Question-naire-Reported Imple-menta-tions	Original Imple-menta-tions	Question-naire-Reported Imple-menta-tion Rate	Approx. Std. Err. of Survey Rate	Original Imple-menta-tion Rate	Approx. Std. Err. of Original Rate
Unit: Energy Basis, Benefit Type: All ARs (But No Reps)								
92	1	6	1.5	4	0.25	.	0.67	.
93	8	51	26.1	25	0.51	0.12	0.49	0.07
94	9	66	27.5	36	0.42	0.07	0.55	0.07
95	11	76	37.1	44	0.49	0.08	0.58	0.10
96	10	69	34.4	38	0.50	0.09	0.55	0.08
97	3	35	8.8	10	0.25	0.16	0.29	0.17
All	42	303	135.3	157	0.45	0.04	0.52	0.04
Unit: Energy Basis, Benefit Type: Previously Implemented (Baseline)								
92	1	4	1.5	4	0.38	.	1.00	.
93	8	25	17.4	25	0.69	0.11	1.00	0.00
94	9	36	22.0	36	0.61	0.12	1.00	0.00
95	11	44	31.8	44	0.72	0.08	1.00	0.00
96	10	38	27.4	38	0.72	0.14	1.00	0.00
97	3	10	5.8	10	0.58	0.03	1.00	0.00
All	42	157	105.9	157	0.67	0.05	1.00	0.00
Unit: Energy Basis, Benefit Type: Previously Unimplemented								
92	1	2	0.0	0	0.00	.	0.00	.
93	8	26	8.7	0	0.33	0.11	0.00	0.00
94	9	30	5.5	0	0.18	0.07	0.00	0.00
95	11	32	5.2	0	0.16	0.05	0.00	0.00
96	10	31	7.0	0	0.23	0.05	0.00	0.00
97	3	25	3.0	0	0.12	0.14	0.00	0.00
All	42	146	29.4	0	0.20	0.04	0.00	0.00

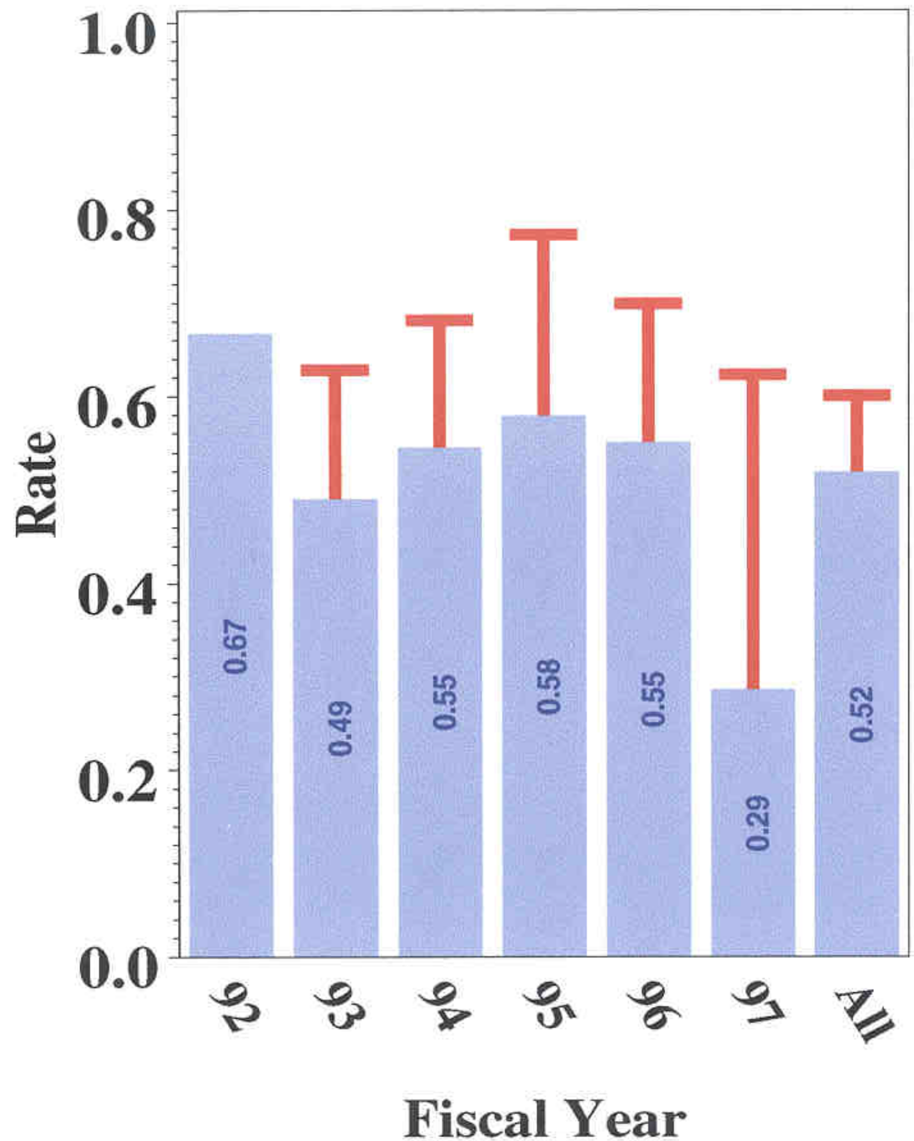

Fig. 3.4. Original implementation rates for participating clients (cost basis). 95% confidence bounds are represented by the narrow bars; test for differences among years is not significant ($p = 0.61$).

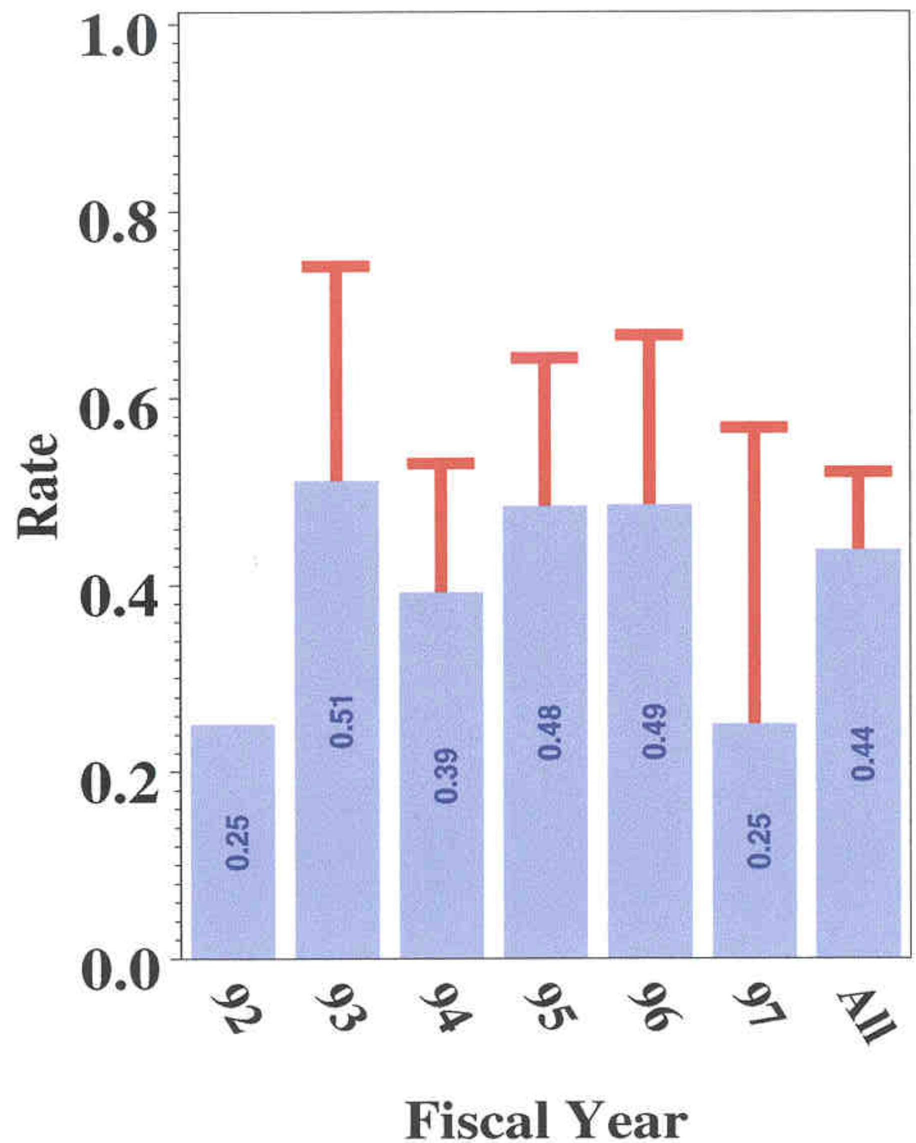

Fig. 3.5. Client reported implementation rates (cost basis). 95% confidence bounds are represented by the narrow bars; test for differences among years is not significant ($p = 0.60$).

3.4 DECISION MODEL RESULTS: CLIENT IMPACT STUDY

The client follow-up questionnaire contained several questions pertaining to EE decision making. The answers given by the respondents suggest that involvement with the IAC Program correlates with improved EE decision making and other activities. For example, Table 3.5 reports that all forty respondents have gone beyond the assessments to implement other activities. Several of the most frequently implemented actions—being more energy-conscious about new equipment and processes and about plant operation—point to a routinization (stage 5 in Fig. 2.1) if not an inculturation (stage 6 in Fig. 2.1) of EE decision making in these firms.

Table 3.5. Other client energy efficiency-related actions taken

Actions	Frequency	%
Established an in-house conservation program	12	30
Designated an existing employee as in-house energy manager	16	40
Hired an energy manager or energy engineer	1	2.5
Worked with an energy services company	11	27.5
Worked more closely with local utilities to identify opportunities to save energy and money	26	65
Encouraged energy-conscious specifications in selection of new equipment	32	80
Encouraged energy-conscious specifications in design or redesign of processes	23	57.5
Encouraged energy-conscious operations of plant equipment	34	85
Trained employees in energy management/energy awareness	16	40
Continued relationship with IAC	7	17.5
Took advantage of other programs through state or local governments	5	12.5
None	0	0

Figures 3.6 and 3.7 offer additional support that involvement with the IAC Program leads to improved EE decision making. With respect to the first figure, respondents were asked how frequently they identified energy savings opportunities before and after the IAC assessment. Fewer than 20% answered that this was done frequently or very frequently before the assessment, but almost 80% answered this was done frequently or very frequently after the assessment. Similarly, with respect to the second figure, fewer than 10% of the respondents answered that they frequently or very frequently implemented energy savings measures before the assessment, but more than 60% reported they frequently or very frequently implemented energy savings measures after the assessment. A T-test shows that the before and after differences are statistically significant at the 0.001 level.

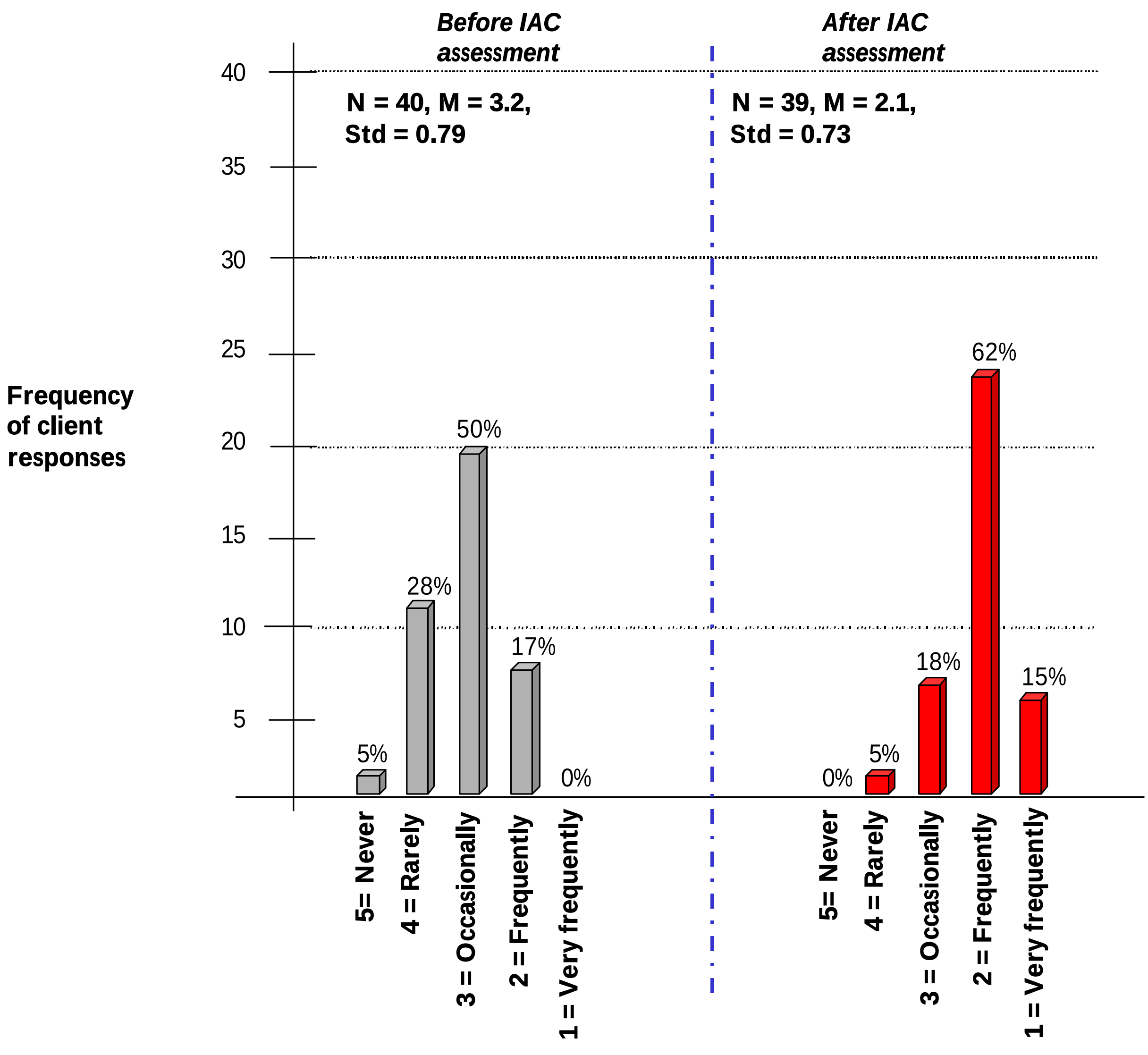

Fig. 3.6. Frequency of energy savings opportunities identified by clients before and after IAC assessments.

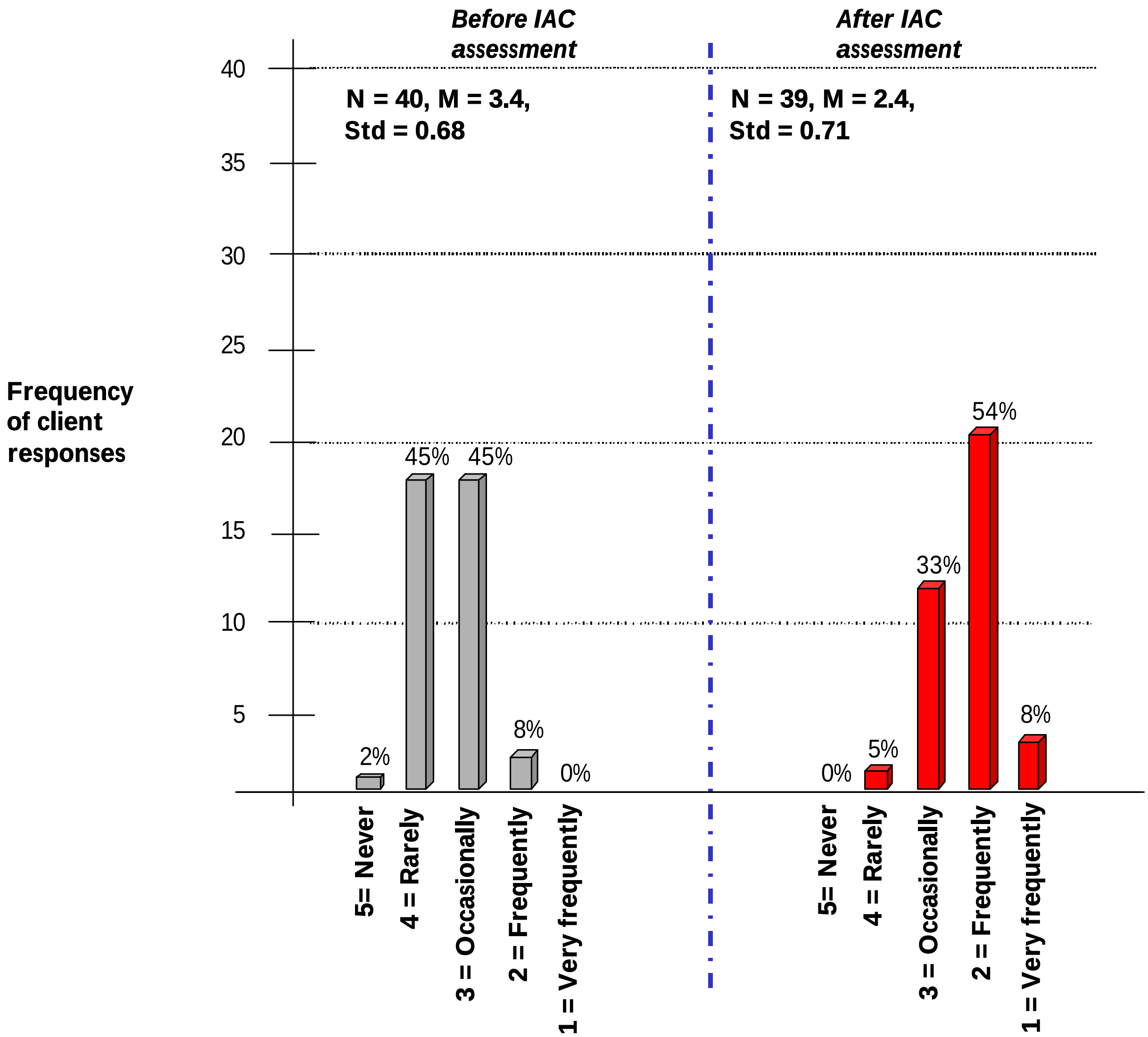

Fig. 3.7. Frequency of energy savings opportunities implemented before and after IAC assessments.

Figure 3.8 illustrates major changes in the stages in the EE decision-making model (as presented in Sect. 2.2) experienced by clients before and after the IAC assessments. Before the assessment, only 5% of the clients could be categorized as falling into the last three stages of the life cycle model—routinization, inculturation, or steady state. After the assessment, more than 60% could be so categorized. This change is also statistically significant at the 0.001 level.

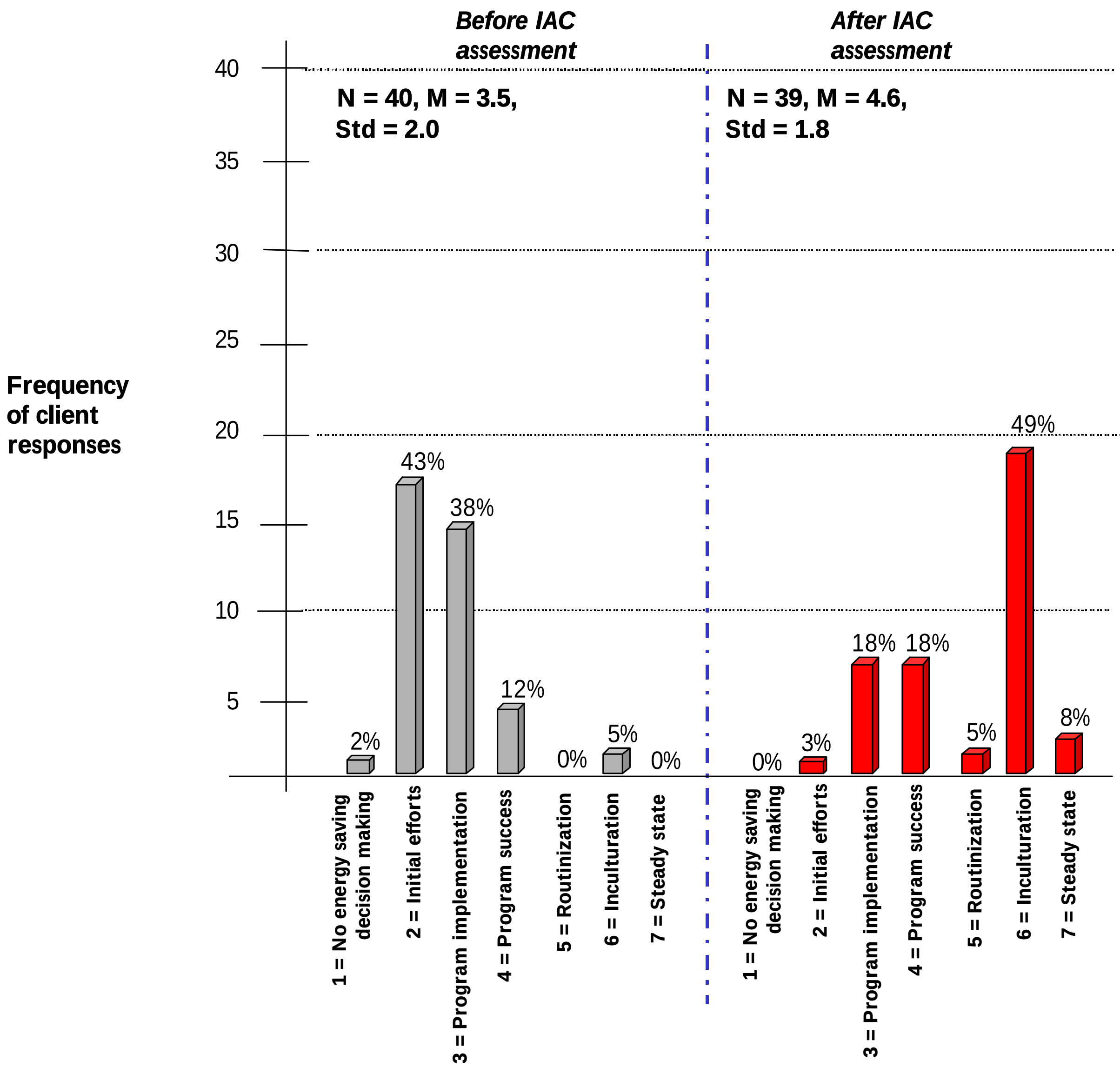

Fig. 3.8. Stages in the life cycle model of industrial energy-efficiency decision making as reported by clients before and after IAC assessments.

It was hypothesized that improvements in EE decision making would also be observable as an improvement in the actual performance of projects, resulting in paybacks of 2 years or less after IAC assessments. Figure 3.9 indicates that this hypothesis was not supported by the data. The sample showed only a small, statistically insignificant (0.30 level for the T-test) increase in the percentage of investments performing with this payback criterion. Table 3.6 indicates that there is little difference in the actual payback rates by stage in the life cycle model, where one might expect a higher percentage in the more advanced stages in the model. These results may suggest, however, that firms are making less than economically efficient investments. For example, they may be willing to accept longer payback periods for more major investments and for R&D types of projects. Also, payback does not include other, nonmonetary factors that may affect investment decision making. Because this finding is consistent across clients, alumni employers, and Website users, additional research is recommended to better understand this aspect of decision making.

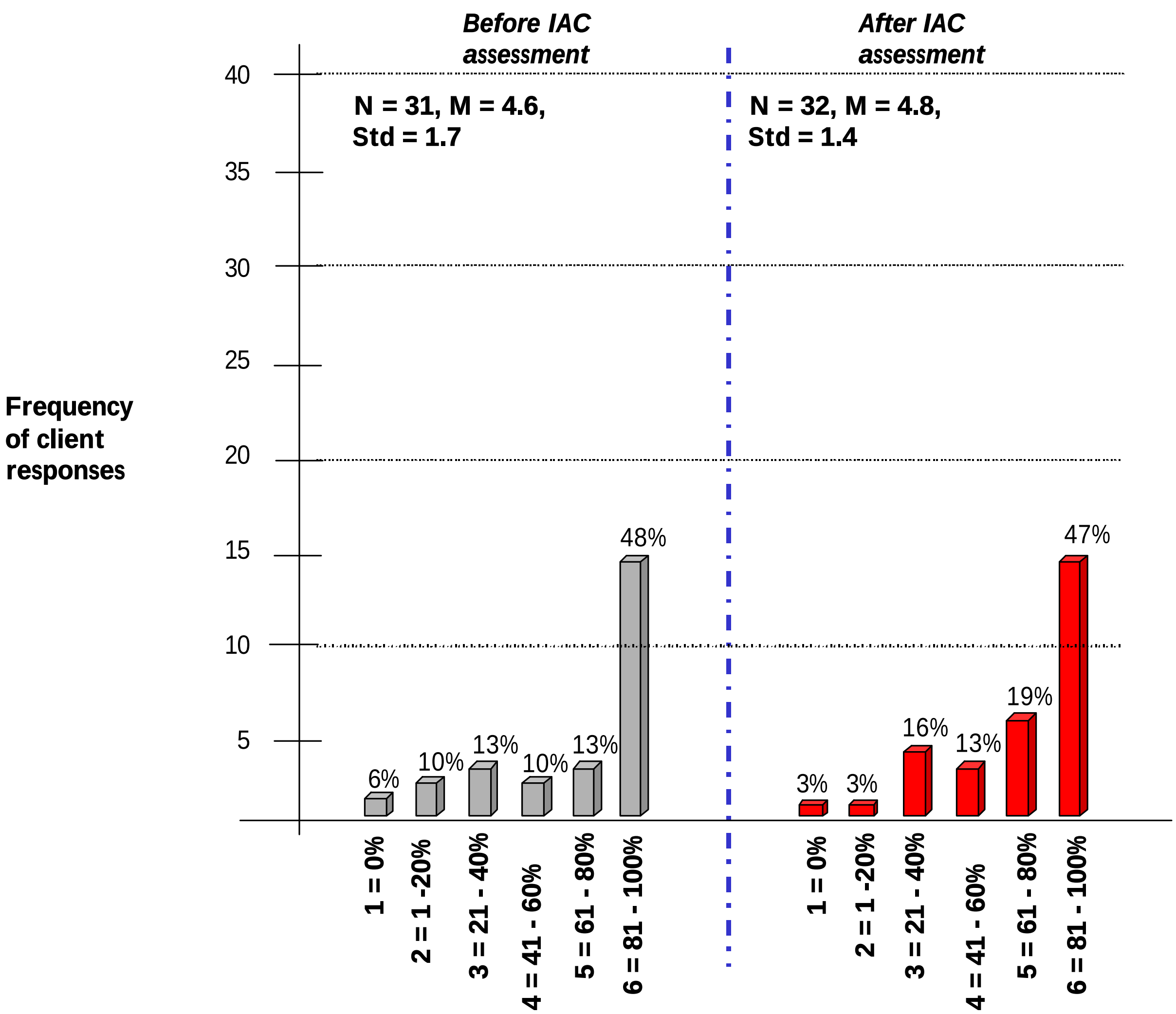

Fig. 3.9. Performing payback rates of 2 years or less before and after IAC assessments.

Table 3.6. Fraction of implemented measures with paybacks under 2 years by stages in the life cycle model of industrial energy saving decision making.

	Client Response (N = number of respondents)						
	No Energy Savings Decision Making	**Initial Efforts**	**Program Implemen-tation**	**Program Success**	**Routinization**	**Inculturation**	**Steady State**
Experienced 2-year Paybacks Before IAC Visit	0	4.7 (12)	4.75 (12)	4.0 (5)	0	4.5 (2)	0
Experienced 2-year Paybacks After IAC Visit	0	6.0 (1)	5.7 (6)	4.5 (6)	5.0 (2)	4.4 (14)	5.3 (3)

Ratings: Percentage of time that paybacks perform under 2 years: (1) 0%; (2) 1c20%; (3) 21–40%; (4) 41–60%; (5) 61–80%; (6) 81–100%.

3.5 PRELIMINARY CONCLUSIONS AND RECOMMENDATIONS

3.5.1 Miscellaneous Observations on Delivery of the Client Follow-up Questionnaire

During the development phase of the project, there was great concern regarding the client's reception of the follow-up questionnaire. Issues such as client ability to recall IAC recommendations, client confidentiality, and client availability needed to be addressed. Of the 102 clients selected by random sampling, 48 agreed to participate and 42 actually completed the questionnaire. The targeted response rate was 50%, which was not far from the actual response rate of 41%. Of these 42 clients, only 2 required additional assurances of confidentiality. A greater obstacle to the implementation of the follow-up questionnaire proved to be the collection of client contact information and original assessment reports from the centers themselves. These requests for information from the Directors, while essential, may have placed an additional burden on centers already stretched by day-to-day program responsibilities. More than obstacles that result from client recall, availability, and confidentiality concerns, future work will need to consider contributions of the centers when scheduling and conducting follow-up interviews.

The use of the original assessment reports was essential to the successful implementation of the questionnaire. Whereas several centers were reluctant to share this information, as a contractor to DOE, ORNL considered itself bound to the original guarantees of confidentiality established by the centers. The benefits of report availability were multiple. Assessment reports helped the interviewer to better prepare and conduct the client interviews. Client recall was enhanced when clients were allowed to review executive summaries and/or AR summaries prior to and during the interviews. Finally, in cases where clients provided limited information on partially implemented, replicated, or miscellaneous ARs, the assessment report was used (along with client comments) to develop engineering estimates of the additional savings.

3.5.2 Recommendations for Full Study, Sample Size and Approach

The pilot client study demonstrates the feasibility of scientifically sampling IAC clients to provide hindsight comparisons of original IAC savings estimates with estimates of savings actually achieved. Only very minor problems were encountered, the most serious of which is that the method of recording client responses for internal and external replication did not fully itemize by AR. This made it difficult to back out source energies and replication frequencies, but the deficiency could be corrected easily in a fully developed study.

The client-to-client statistical variability is substantial enough, however, that the pilot data alone are insufficient to defensibly characterize the CBRs of interest. For example, quadrupling the sample size to about 168 would reduce the margin of uncertainty (95% confidence range) of the cost CBR for all FYs to about 0.21 or about 18%. Because the cost CBR is comprehensive, and because it is has a greater standard error (is a worst case) than the source or site energy CBRs, the cost CBR is a reasonable variable to use for standard-error-based sample size estimation.

The pilot data are also too variable to allow for resolution of year-to-year differences in benefit rates. Furthermore, the pilot data go back only to FY 1993 (with one FY 1992 respondent), and the results do not indicate a time-attenuation of savings, as would be expected eventually. In addition to increasing sample sizes, it would also be useful to extend the time range of the study, for example, to FY 1988–97. This would allow an increasing and then decreasing benefit curve to be reckoned and would perhaps provide a defensible basis for extending the time range of client benefit to 10 or more years. The main goal would be to assess persistence, however; estimating the shape of the CBR-vs-time curve would be secondary.

To ensure a reasonable representation of FYs in the data, it would be a good idea to stratify the study by FY, that is, to sample a predetermined number of clients whose assessments were in each FY in the time range of interest (e.g., FY 1988–97). Thus, in a fully developed client study, it would be reasonable to allocate sampling uniformly over FYs or perhaps to favor later years slightly because results for later years are more timely and likely to be more reliable. (As greater nonresponse would be expected for earlier years, larger initial sample sizes will likely be needed for earlier years to ensure an approximately uniform time distribution among the responders.) Also, the pilot study results from FY 1992-97 can be incorporated with additional samples, and the number of additional samples can be adjusted accordingly.

The importance of persistence and estimating FY-specific CBRs suggests that FY should be the focus of any stratification scheme. In addition to FY, other variables of interest as potential stratification variables include SIC or AR category (e.g., energy, waste, productivity). As the pilot data do admit resolution of year-to-year differences in benefit rates, it seems unlikely that reasonably precise estimates of CBRs specific to FY and any additional stratification variable would be feasible, even in a fully developed survey. Table 3.7 shows the numbers of ARs and assessments by AR type in the pilot study data:

Table 3.7. Frequencies of ARs and assessments in the pilot study data (ARs/assessments)

AR Category	FY 1992	FY 1993	FY 1994	FY 1995	FY 1996	FY 1997	All FYs
Energy	6/1	50/8	60/9	67/11	54/10	24/3	261/42
Waste	0/1	1/1	6/3	9/4	15/9	9/3	40/20
Productivity	0/0	0/0	0/0	0/0	0/0	2/2	2/2
All ARs	6/1	51/8	66/9	76/11	69/10	35/3	303/42

The standard errors of the CBR estimates depend on the numbers of assessments (not ARs). Thus, reasonable CBR estimates that are specific to both FY and AR category would be difficult to acquire.

Client nonresponse is a troublesome issue, but the frequency of nonresponse as the result of plant closures or client outright refusal to respond is not large (23%). Nonresponse for reasons such as failure to make telephone contact or IAC center closure are less serious. Because client confidentiality precludes a good solution to the problem of nonresponse, as a rough approximation, it is reasonable to disregard the problem of nonresponse.

A tentative suggestion for a fully developed client study would be to repeat the pilot design within each FY, covering years from 1988 through 1997 (and with internal and external replication fully itemized by AR). Table 3.8 suggests target total client response frequencies. The approximate standard errors in the table are for the cost CBR and are based on the assumption that client-to-client variability is the same within years as overall. Variables other than the cost CBR could be considered instead and may be of greater interest.

Table 3.8. Suggested sample sizes for a fully developed IAC client study

FY	Already Sampled in Pilot Study	Additional Responders (Target)	Total (Target)	2 × Approx. Std. Err. of Cost CBR
1997	3	22	25	0.54
1996	10	15	25	0.54
1995	11	14	25	0.54
1994	9	16	25	0.54
1993	8	15	23	0.57
1992	1	20	21	0.61
1991	0	20	20	0.61
1990	0	20	20	0.61
1989	0	20	20	0.61
1988	0	20	20	0.61
All	42	182	224	0.18

4. ALUMNI IMPACT STUDY

4.1 QUESTIONNAIRE DESIGN

The alumni follow-up questionnaire can be found in Appendix B. It was designed to collect four types of information:

- energy and cost savings—to support the analysis outlined in Sect. 2.1;
- changes in energy decision making—to support the analysis outlined in Sect. 2.2;
- contribution of the IAC Program to alumni career success; and
- alumni work history.

For the first type of information, the questionnaire directly asked alumni to estimate energy and related cost savings attributable to their efforts for the years 1995–1998 (see Q13). They were asked to indicate what type of fuel was saved. They were allowed to provide a range (low to high) of estimated energy and related costs savings. On the back of the questionnaire was a worksheet to help the respondents prepare these estimates. They were also asked about cost savings attributable to their efforts related to waste minimization and productivity improvements (see Q14).

With respect to energy decision making, several questions were designed to indicate situations before and after the arrival of the alumni at the firm were they are employed or act as a consultant.

Thirdly, questions were designed to gather information on how participation in the IAC Program benefitted students in the job market. Information on starting salaries was collected (see Q5) and alumni were asked about what skills were imparted by participation in the IAC Program (Q6). Lastly, several questions were designed to develop a description of the respondents' current positions. (A summary of respondents' characteristics may be found in Appendix B.2.)

4.2 DATA COLLECTION DESIGN

A database containing contact information for 656 IAC alumni was obtained from Rutgers University. From these 656, center directors at each of the 29 operating IACs were asked to identify the names of IAC alumni who the center directors believed were particularly successful in working in industry to save energy (hereafter referred to as "stars"). Of the 29 centers contacted, 25 responded and identified a total of 77 stars.

Based upon the desire to contact as many as possible of the 656 alumni for whom addresses existed, and given time and budget constraints, it was decided to first mail a follow-up questionnaire. Mailed to all 656 alumni were a cover letter, a questionnaire, and a postage-paid return envelope. After approximately 3 weeks, a second round of contacts with the alumni were initiated. The alumni identified by the center directors, or "stars," who had not completed questionnaires were sent a second cover letter, questionnaire, and envelope. All other alumni who had not responded were sent reminder postcards. After another 3 weeks, attempts were made to telephone stars who had not responded. Contact with 19 stars was attempted in this way. Also, a second reminder card was sent to all the other alumni.

These three rounds of effort produced 132 completed questionnaires—40 from stars and 92 from other alumni. Approximately 150 questionnaires and cards were returned because of bad addresses. Thus, of the approximately 500 alumni (both stars and others) for whom mail contact was attempted, the overall response rate was 26.4%. The response rate for the stars was 52% and for the other alumni 22%. This project did not attempt to assess formally whether responders differed in any way from nonresponders. However, cursory assessment of energy savings reported by alumni who quickly returned their questionnaires and those who needed several reminders showed no discernable differences.

4.3 ENERGY AND COST SAVINGS RESULTS

This section reports on total energy savings, total energy cost savings, and total waste reduction/productivity enhancement cost savings attributable to alumni of the IAC Program for the years 1995–1998. It also reports savings broken down by two categories of IAC alumni: those who IAC centers identified as ‘stars’ and other alumni.

The results are presented under two assumptions:

- *Assumption 1*: In this baseline case, the only energy and cost savings that can be attributable to IAC alumni are those derivable from the 132 completed questionnaires.
- *Assumption 2*: Energy and cost savings can be generalized to the larger IAC alumni population by assuming that the response rate would have been the same had all alumni (estimated to be 1420 through FY 1998)[1] received questionnaires and that this larger number of alumni would have reported mean alumnus energy and cost savings equal, on average, to that of the sample of 132. This assumption increases energy and cost savings estimates between a factor of 2.8 and 3.3, depending on the year of the estimates.

As Tables 4.1, 4.2 , 4.3, and 4.4 indicate, which assumption is chosen greatly affects the total energy savings, total energy cost savings, and total waste reduction/productivity enhancement cost savings attributable to IAC alumni. Tables 4.1 and 4.2 describe in billions of Btus per year total annual site and source energy savings, respectively. Tables 4.3 and 4.4 describe energy cost savings and cost savings from waste reduction and productivity enhancement, respectively.

[1] This number was calculated by tracking the number of schools participating in the IAC Program in each fiscal year since 1981 and assuming an average of 4.67 graduates per school per fiscal year.

Table 4.1. Total annual site energy savings (billions Btu/yr) generated by IAC alumni

	Assumption 1. Energy Savings - Lower Bound	Assumption 1. Energy Savings - Upper Bound	Assumption 2. Energy Savings - Lower Bound	Assumption 2. Energy Savings - Upper Bound
1998	853	1,355	2,474	3,930
1997	468	730	1,310	2,044
1996	176	310	528	930
1995	247	357	815	1,178
4-yr avg.	436	688	1,282	2,021

Table 4.2. Total annual source energy savings (billions Btu/yr) generated by IAC alumni

	Assumption 1. Energy Savings - Lower Bound	Assumption 1. Energy Savings - Upper Bound	Assumption 2. Energy Savings - Lower Bound	Assumption 2. Energy Savings - Upper Bound
1998	1,926	2,275	5,585	6,598
1997	971	1,435	2,719	4,018
1996	378	558	1,134	1,674
1995	592	721	1,954	2,379
4-yr avg.	967	1,247	2,848	3,667

Table 4.3. Total annual energy cost savings (millions $/yr) generated by IAC alumni.

	Assumption 1. Cost Savings - Lower Bound	Assumption 1. Cost Savings - Upper Bound	Assumption 2. Cost Savings - Lower Bound	Assumption 2. Cost Savings - Upper Bound
1998	21	27.9	60.9	80.9
1997	16.4	23.6	45.9	66.1
1996	9.7	10.4	29.1	31.2
1995	7.4	8.1	24.4	26.7
4- yr avg.	13.6	17.5	40.1	51.2

Table 4.4. Total annual waste reduction and productivity enhancement cost savings (millions $/yr) generated by IAC alumni

	Assumption 1. Waste and Productivity Cost Savings Lower Bound	Assumption 1. Waste and Productivity Cost Savings Upper Bound	Assumption 2. Waste and Productivity Cost Savings Lower Bound	Assumption 2. Waste and Productivity Cost Savings Upper Bound
1998	26.1	28.6	75.7	82.9
1997	3.1	4.5	8.7	12.6
1996	1.0	1.7	3.0	5.1
1995	0.3	0.4	1.0	1.3
4-yr avg.	7.6	8.8	22.1	25.5

Tables 4.5, 4.6, and 4.7 report mean energy savings, energy cost savings, and waste reduction/productivity enhancement cost savings generated by stars and by other alumni. These results are reported only for Assumption 1. Tables 4.8 and 4.9 breakout annual source energy savings into electricity savings and savings associated with other fuels (mainly natural gas), respectively.

Table 4.5. Mean annual source energy savings (billions Btu/yr) per IAC alumnus

	Star Alumni Energy Savings - Lower Bound	Star Alumni Energy Savings - Upper Bound	Other Alumni Energy Savings - Lower Bound	Other Energy Savings - Upper Bound
1998	15.7	28.4	2.9	2.9
1997	6.7	13.3	2.5	2.5
1996	1.6	4.7	1.3	1.5
1995	1.5	4.3	2.2	2.3
4-yr avg.	6.4	12.7	2.2	2.3

Table 4.6. Mean annual energy cost savings (thousands $/yr) per IAC alumnus

	Star Alumni Cost Savings - Lower Bound	Star Alumni Cost Savings - Upper Bound	Other Alumni Cost Savings - Lower Bound	Other Alumni Cost Savings - Upper Bound
1998	283	381	119	158
1997	163	326	122	129
1996	102	110	68	74
1995	77	82	52	57
4-yr avg.	156	225	90	105

Table 4.7. Mean annual waste reduction and productivity enhancement cost savings (thousands $/yr) per IAC alumnus

	Star Alumni Waste and Productivity Cost Savings - Lower Bound	Star Alumni Waste and Productivity Cost Savings - Upper Bound	Other Alumni Waste and Productivity Cost Savings - Lower Bound	Other Alumni Waste and Productivity Cost Savings - Upper Bound
1998	73	78	259	285
1997	7	9	31	46
1996	0	0	11	19
1995	0	0	3	5
4-yr avg.	20	22	76	89

Table 4.8. Annual source electrical energy savings (billions Btu/yr) generated by IAC alumni

	Assumption 1. Electricity Savings Lower Bound	Assumption 1. Electricity Savings Upper Bound	Assumption 2. Electricity Savings Lower Bound	Assumption 2. Electricity Savings Upper Bound
1998	1,604	2,123	4,652	6,186
1997	752	1009	2,106	2,825
1996	302	371	906	1,113
1995	516	544	1,703	1,795
4-yr avg.	794	1,012	2,342	2,980

Table 4.9. Annual source energy savings for other fuels (billions Btu/yr) generated by IAC alumni

	Assumption 1. Other Fuel Savings Lower Bound	Assumption 1. Other Fuel Savings Upper Bound	Assumption 2. Other Fuel Savings Lower Bound	Assumption 2. Other Fuel Savings Upper Bound
1998	322	652	934	1,891
1997	219	396	613	1,109
1996	76	187	228	561
1995	76	177	251	584
4-yr avg.	173	353	507	1,036

4.4 DECISION MODEL RESULTS

This section reports results with respect to the life cycle energy savings decision model set out in Sect. 2.2. The IAC alumni are shown to have had a significant influence upon the energy savings decision-making behavior of their employers. This section begins with an assessment of problems common to energy savings decision making before and after alumni arrived and the reported influences of the alumni upon resolving these problems. Next, the frequency with which alumni employers identified and adopted energy savings measures before and after alumni arrived is reviewed. Third, changes in payback performance associated with energy savings decisions before and after alumni arrived was reviewed. In all these cases, alumni have had a statistically significant positive impact upon their employers' energy savings decisions. The section concludes with an assessment of how each employer falls into the life cycle energy savings model presented in Fig. 2.1, before and after the alumni arrived.

Table 4.10 indicates that alumni reported that their employers suffered many problems related to energy savings decision making before the alumni arrived. Each of the five problems—lack of knowledge about energy savings opportunities, lack of knowledge about the cost of energy saving measures, lack of knowledge about how to quantify energy savings benefits, lack of knowledge about other benefits (e.g., environmental) of energy savings measures, and lack of knowledge about how to make energy savings decisions—was encountered at about the same rate. About one-third of the

Table 4.10. Problems common to energy savings decision making before alumni arrived.

	N	Never (1)	Rarely (2)	Sometimes (3)	Frequently (4)	Always (5)	Mean	Standard
Lack of knowledge about energy savings opportunities	88	7 8.0%	20 22.7%	32 36.4%	23 26.1%	6 6.8%	3.0	1.0
Lack of knowledge about cost of energy savings measures	88	8 9.1%	23 26.1%	29 33.0%	20 22.7%	8 9.1%	3.0	1.1
Lack of knowledge about how to quantify energy savings benefits	89	6 6.7%	25 28.1%	23 25.8%	21 23.6%	14 15.7%	3.1	1.2
Lack of knowledge about other benefits (e.g.,environmental) of energy savings measures	86	8 9.3%	21 24.4%	24 27.9%	24 27.9%	9 10.5%	3.0	1.2
Lack of knowledge about how to make energy savings decisions	87	8 9.2%	28 32.2%	24 27.6%	22 25.3%	5 5.7%	2.9	1.1

employers suffered these problems frequently or always. Only about one-third rarely or never encountered these problems. Table 4.11 indicates that after alumni arrived, the frequency of the problems dropped. Only about 10% of the employers now suffered these problems frequently or always, whereas about 60% now rarely or never suffer these problems. Table 4.12 indicates that most of the alumni respondents perceived to have had at least a moderate influence on overcoming these problems. Table 4.13 presents T-test results that indicate that the changes in the means of the five common problems are positive and statistically significant. Thus, IAC alumni perceived that they have had a positive influence in helping their employers overcome common problems in energy savings decision making.

Table 4.11. Problems common to energy savings decision making after alumni arrived

	N	Never (1)	Rarely (2)	Sometimes (3)	Frequently (4)	Always (5)	Mean	Standard
Lack of knowledge about energy savings opportunities	89	12 13.5%	48 53.9%	21 23.6%	7 7.9%	1 1.1%	2.3	0.8
Lack of knowledge about cost of energy savings measures	87	10 11.5%	50 57.5%	19 21.8%	6 6.9%	2 2.3%	2.3	0.9
Lack of knowledge about how to quantify energy savings benefits	88	13 14.8%	47 53.4%	16 18.2%	10 11.4%	2 2.3%	2.3	0.9
Lack of knowledge about other benefits (e.g., environmental) of energy savings measures	87	13 14.9%	40 46.0%	23 26.4%	8 9.2%	3 3.4%	2.4	1.0
Lack of knowledge about how to make energy savings decisions	85	14 16.5%	44 51.8%	17 20.0%	8 9.4%	2 2.4%	2.3	0.9

Table 4.12. Perceived alumni influence on overcoming common barriers to energy-savings decision making

	N	None (1)	Minimal (2)	Moderate (3)	Strong (4)	Sole (5)	Mean	Standard
Lack of knowledge about energy savings opportunities	83	8 9.6%	18 21.7%	33 39.8%	21 25.3%	3 3.6%	2.9	1.0
Lack of knowledge about cost of energy savings measures	83	9 10.8%	21 25.3%	27 32.5%	22 26.5%	4 4.8%	2.9	1.1
Lack of knowledge about how to quantify energy savings benefits	84	7 8.3%	22 26.2%	24 28.6%	26 31.0%	5 6.0%	3.0	1.1
Lack of knowledge about other benefits (e.g., environmental) of energy savings measures	84	10 11.9%	19 22.6%	36 42.9%	16 19.0%	3 3.6%	2.8	1.0
Lack of knowledge about how to make energy savings decisions	82	11 13.4%	23 28.0%	27 32.9%	17 20.7%	4 4.9%	2.8	1.1

Table 4.13. Changes in issues relating to energy-savings decision making after and before alumni

Barriers	N	Mean Shift	Std. Error	T	Prob. |T|
Lack of knowledge about energy savings opportunities	86	0.7	0.1	7.5	0.0001
Lack of knowledge about cost of energy savings measures	84	0.6	0.1	6.5	0.0001
Lack of knowledge about how to quantify energy savings benefits	85	0.8	0.1	6.6	0.0001
Lack of knowledge about other benefits (e.g., environmental) of energy savings measures	84	0.7	0.1	6.3	0.0001
Lack of knowledge about how to make energy savings decisions	82	0.6	0.1	5.3	0.0001

This influence carried over into the identification and actual adoption of energy saving measures by the alumni employers. Figure 4.1 illustrates the frequency of energy savings opportunities identified before and after the alumni arrived. Visually, one can see that the number of alumni responses shifts to the right (i.e., to the “frequently” and “very frequently” answers) after the alumni arrived. The change in the mean response, from a mean of 3.1 to 3.8, confirms this visual observation, as does a T-test ($T = 6.6$, $p = 0.0001$). A similar story is conveyed by Fig. 4.2, which illustrates the frequency of energy savings opportunities implemented before and after the alumni arrived. The change in means is from 2.9 to 3.5 ($T = 5.5$, $p = 0.0001$). Thus, a second conclusion that can be made is that the IAC alumni have had a positive influence on the identification and adoption of energy savings measures by their employers.

Table 4.14 indicates that employers are also engaging in numerous other activities that can support energy savings in their operations. For example, more than 30% now encourage energy-conscious specifications in the selection of new equipment, and almost 30% encourage energy-conscious specifications in the design or redesign of processes. Many employers are working closely with their local utilities to identify opportunities to save energy and money, encouraging energy-conscious operations of plant equipment, and are training employees in energy management/energy awareness. These activities are the kinds of activities that firms would engage in to move themselves through the life cycle of energy-efficiency decision making, to at least routinize energy considerations in everyday decision making if not change the firm’s culture. It is interesting to note that almost 16% of the employers (possibly through the alumni) have maintained some contact with the IAC Program.

The methodology presented in Sect. 2.2 to categorize firms/organizations by their stage in the industrial energy savings life cycle model was applied to the alumni employers. Figure 4.3 indicates that before the alumni arrived, most firms fell into the program implementation stage or before, which would suggest their need to hire an IAC alumnus. It is interesting to note a bimodal distribution on the left-hand side of the figure, where firms either have few energy savings activities or have moved to the final two stages of the life cycle process. Visually, it is clear that after alumni arrived employers typically started to move through the life cycle process (e.g., almost no employers fall into the No Energy Saving Decision-Making category) and many more report now being further along. The mean stage in the life cycle is 3.5 before alumni arrived and 4.7 after, which is statistically significant ($T = 6.0$, $p = 0.0001$).

Table 4.15 indicates the progression through life cycle stages before and after alumni arrived. Among those employers whose stage changed, most moved one stage along the life cycle, although more than 20% moved three or more stages. Only one employer backtracked. Data were not collected to indicate how much time was needed to move from one stage to the next. However, because most of the alumni respondents graduated in the mid- to late 1990s, one can argue that moving from one stage to the next, if not moving multiple stages, requires only a few years rather than decades of time.

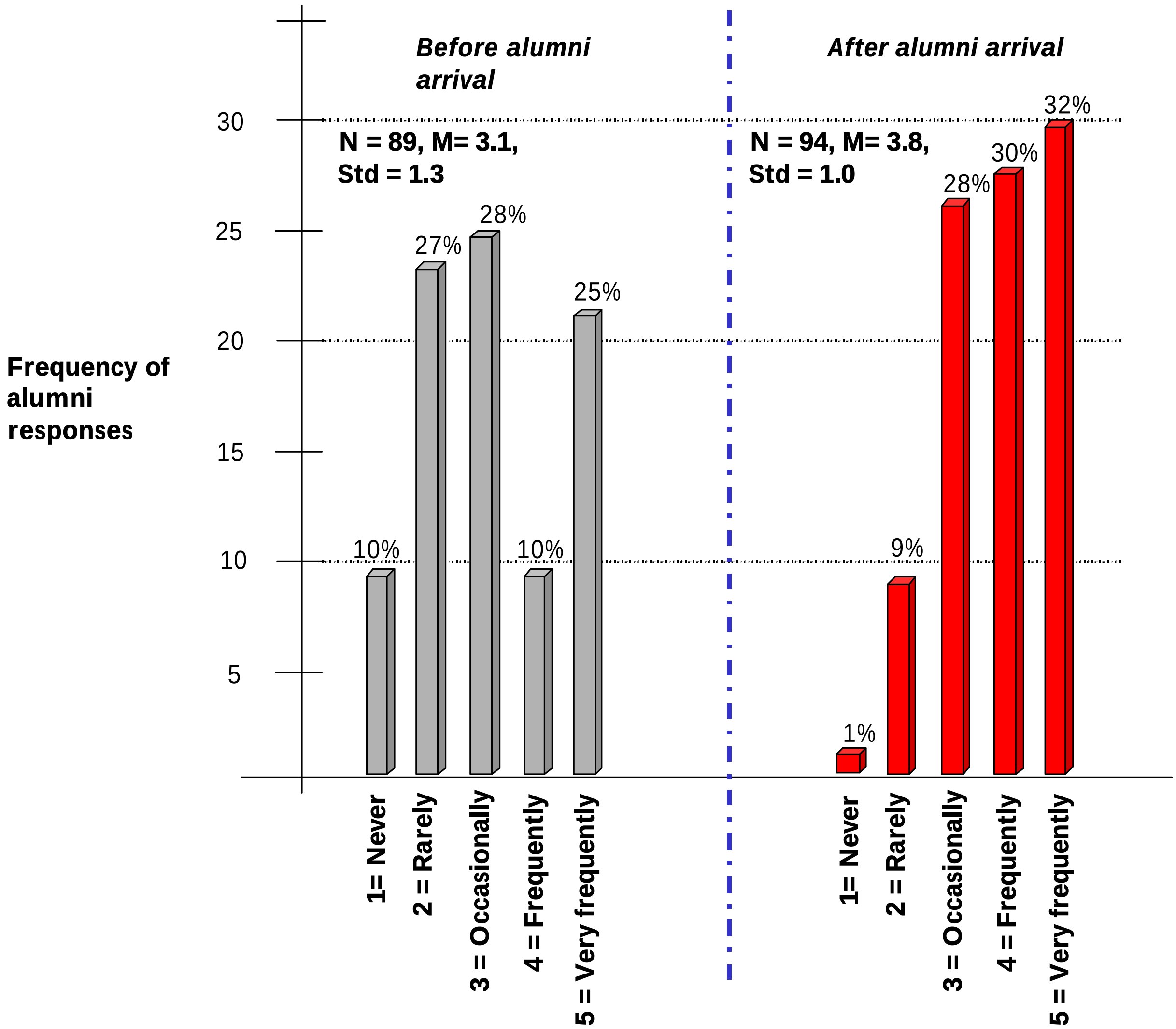

Fig. 4.1. Frequency that energy savings opportunities were identified by alumni employers before and after alumni arrived.

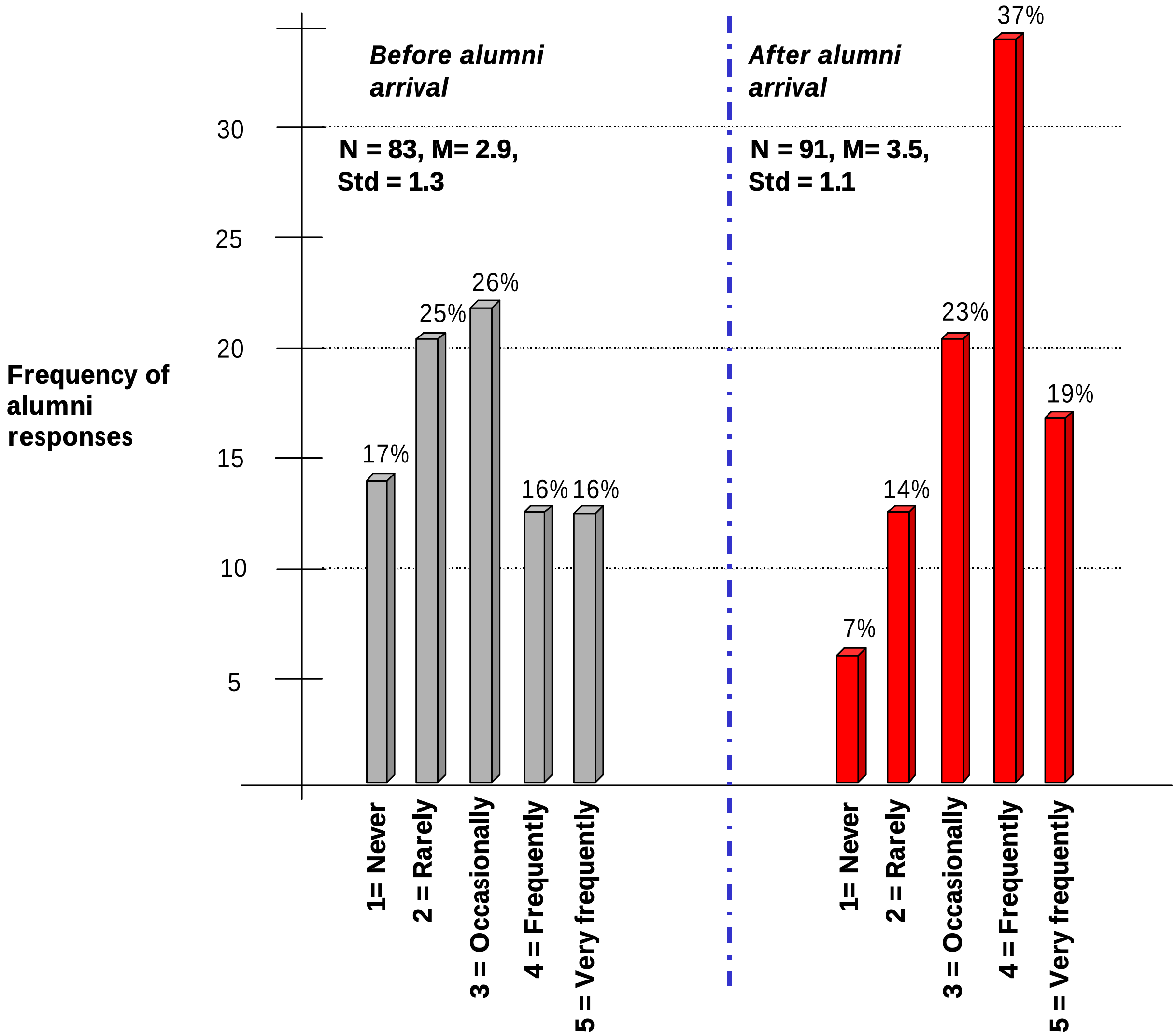

Fig. 4.2. Frequency that energy savings opportunities were implemented by alumni employers before and after alumni arrived.

Table 4.14. IAC alumni employer actions taken to save energy.

Actions	Frequency	Percent
Established an in-house conservation program	12	9.1
Designated an existing employee as in-house energy manager	13	9.8
Hired an energy manager or energy engineer	8	6.1
Worked with an energy services company	18	13.6
Worked more closely with local utilities to identify opportunities to save energy and money	31	23.5
Encouraged energy-conscious specifications in selection of new equipment	42	31.8
Encouraged energy-conscious specifications in design or redesign of processes	37	28.0
Encouraged energy-conscious operations of plant equipment	31	23.5
Trained employees in energy management/energy awareness	26	19.7
Continued relationship with IAC	21	15.9
Took advantage of other programs through state or local governments	17	12.9
Other	0	0
None	18	13.6

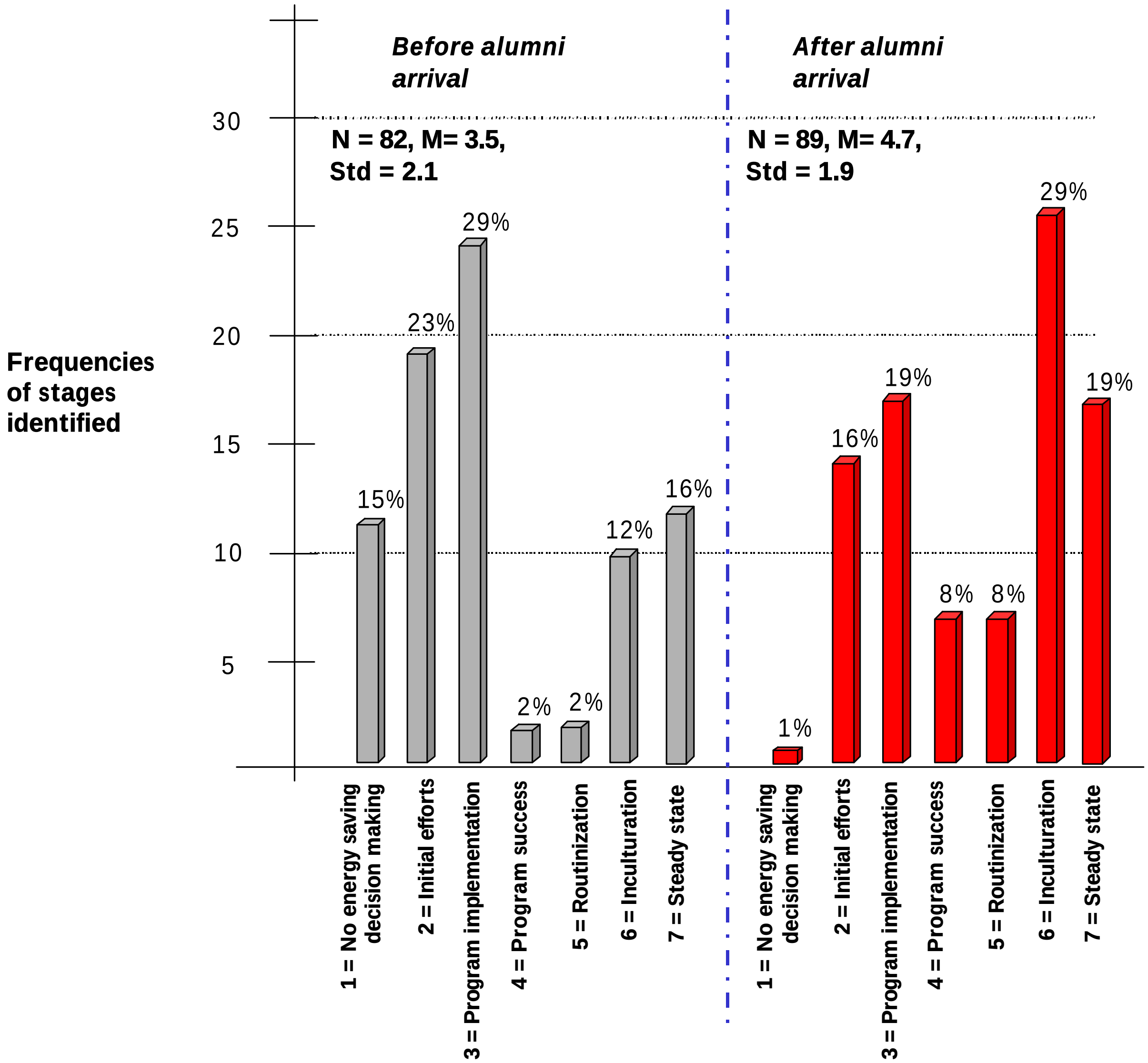

Fig. 4.3. Stages in the life cycle model of industrial efficiency decision making as reported by alumni about their employers before and after their arrival.

Table 4.15. Progression through life cycle stages from before to after arrival of IAC alumni (N = 81)[a]

Number of stages progressed	!5	0	1	2	3	4	5	6
Number of employers	1	39	17	5	6	8	4	1
Percent of employers	1.2%	48.1%	21.0%	6.2%	7.4%	9.9%	4.9%	1.2%

[a] Ranges from !6 to +6

Hiring an IAC alumnus can possibly speed up the life cycle process. To explore this, relationships between the perceived influence alumni respondents reported having on overcoming common problems with energy savings decision making (as reported in Table 4.12) and changes in life cycle stages were explored. Table 4.16 reports total alumni influence, which is the sum of answers to the five influence questions and ranges from a low of 5 to a high of 25, by changes in stages in the life cycle. One can see that the mean sum of the influences increases from left to right, meaning that the more stages the employer moved forward in the life cycle model, the more influence the alumni had in this movement. Thus, one can argue that IAC alumni have had a strong impact on the life cycle stage of their employers' energy savings decision making.

Table 4.16. Mean total alumni influence by progression through the stages in the life cycle model[a]

Number of stages progressed	!5	0	1	2	3	4	5	6
Perceived level of influence [b]	5.0	11.7	15.2	17.6	17.0	17.7	21.7	20.0
Number of respondents	1	32	13	5	6	7	3	1

[a]Ranges from !6 to +6 [b]Ranges from 5 (low) to 25 (high)

Alumni respondents answered questions about payback rates associated with energy savings projects. Specifically, they were asked what percentage of energy savings projects yielded paybacks of 2 years or less before and after the alumni arrived. As indicated in Fig. 4.4, many fewer alumni respondents answered these two questions than the previous questions, possibly indicating that payback calculations are not ubiquitous in industry. However, enough alumni respondents answered the questions to allow a statistical assessment of the answers. First though, visually, one can see that after the alumni arrived, the percentage of energy savings projects with paybacks of 2 years or less increased. The mean increased from approximately the 30% range to the 40% range. This change is statistically significant ($T = 2.7$, $p = 0.0085$). It is also interesting to note that many energy savings projects may have paybacks longer than 2 years. More than 50% of the alumni respondents indicated that more than half of their employers' energy savings projects did not meet this criterion. On a positive note, one can interpret these observations to mean that firms may have longer-term perspectives than is generally thought. In any case, alumni seem to have made an impact on the financial performance of their firms' energy savings decisions. As with the clients, there does not appear to be a relationship between payback rates and the alumni employer's stage in the life cycle model (see Table 4.17).

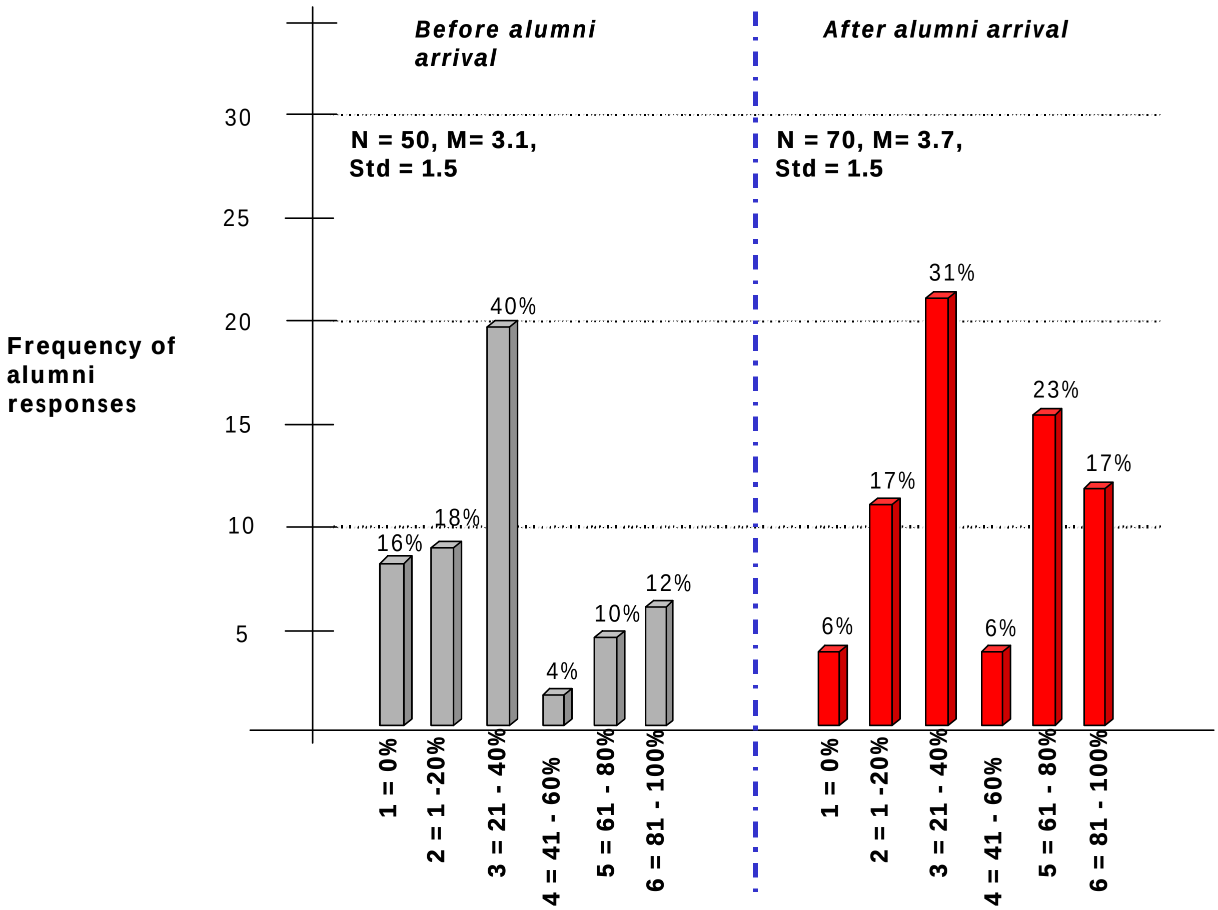

Fig. 4.4. Percentage of energy savings investments by alumni employers yielding payback rates of 2 years or less before and after alumni arrived.

Table 4.17. Fraction of implemented measures with paybacks under 2 years by stages in the life cycle model of energy saving decision making (number of respondents)

	No Energy Savings Decision-Making	**Initial Efforts**	**Program Implementation**	**Program Success**	**Routinization**	**Inculturation**	**Steady State**
Experienced 2-year Payback Before Alumni Arrived	1.0 (6)	2.9 (10	3.6 (14)	4.0 (2)	3.0 (1)	3.2 (9)	3.4 (7)
Experienced 2-year Payback After Alumni Arrived	0	3.1 (8)	4.4 (12)	3.5 (6)	2.7 (7)	3.9 (23)	3.8 (12)

Ratings: Percentage of time that paybacks perform under 2 years: (1) 0%; (2) 1–20%; (3) 21–40%; (4) 41–60%; (5) 61–80%; (6) 81–100%.

4.5 PRELIMINARY CONCLUSIONS AND RECOMMENDATIONS

The study methodology was a useful approach to evaluating the benefits attributable to the IAC Program via student alumni. The questionnaire was able to collect data not only on energy and cost savings but also on EE decision making and about the alumni themselves. As indicated in Appendix B.2, the alumni respondents reported that they benefitted greatly from their IAC Program experiences and are well on their way to rewarding careers.

More alumni could have been participated had the addresses been available. Whether the benefits of maintaining a comprehensive and up-to-date mailing list of IAC alumni is worth the cost is a question that should be considered. The results presented in Table 4.14 indicate that many IAC alumni are keeping their ties with the IAC Program. In addition, Web-based exit interviews with alumni could at least collect information on new addresses after school and provide a point of contact for alumni years afterward.

The initial results on alumni influence on their employers' EE decision making justify continued efforts in this area. As noted above, the use of payback rates in energy investment decision- making can be studied more closely. For example, instead of payback rates, it would be useful to study internal rates of return on investments (ROIs) for firms. How firms incorporate nonmonetary decision-making criteria and whether they apply full-blown life cycle analysis techniques to weigh investments would also be interesting to learn more about.

5. WEBSITE USERS IMPACT STUDY

5.1 QUESTIONNAIRE DESIGN

The purpose of the Website Users questionnaire was to quantify the savings (primarily energy and cost savings) that are being realized through the use of technical information found on IAC Websites. This purpose was broken down into two more specific objectives, which were to determine

- what percentage of those people visiting the IAC Websites that have technical information actually use that information to create extended Program savings; and
- how much savings those people are realizing through direct and replicated implementation of IAC technical information.

The Web study captured qualitative and quantitative data from users of online IAC technical information and was organized into three main sections:

- Section 1: IAC Websites Use & Realized/Potential Extended Savings;
- Section 2: Site Content/Usability; and
- Section 3: User Information.

Before asking the quantitative questions about possible savings incurred from use of IAC online technical information, the first section posed a few qualitative questions to ascertain how and why the visitor came to the site. The remaining questions of Sect. 1 and those of Sects. 2 and 3 were qualitative in nature and addressed a variety of issues, such as assessing the effect of the IAC online technical information in changing an organization's frequency of assessing and acting on energy saving opportunities (the Decision-Making model), and Website users' opinions, preferences, and demographic information. The questionnaire may be found in Appendix C.1. The responses received for the qualitative questions are addressed in Appendix C.2.

Before the Web questionnaire was designed, we reviewed the final report of a previously performed Web study to gain some perspective on the successful implementation of such a task. The Energy Efficiency and Renewable Energy Network (EREN) conducted a customer satisfaction survey in 1997 to collect customer feedback on the Website's performance (Anderson 1997). Whereas these two studies would inevitably be similar in their main goals (obtaining user feedback), several differences were clear and included the following:

- Format—The EREN study used the telephone as a contacting medium (allowing room for more detailed responses), whereas the IAC Web study used Internet-based multiple-choice and fill-in-the-blank questions.
- Respondents—EREN randomly selected names from a list of registered User Group members (people who were considered fairly regular users of the site), whereas the IAC Web study used e-mail addresses captured during users' visits to the Website (not knowing how frequent a visitor he or she might be).

- Particular information needed—The IAC Web study's primary intent was to quantify the extent to which online IAC technical information had been used, whereas the EREN study had focused on both quantifying and qualifying site visitors' satisfaction.

The EREN study set a goal of (and received) 40 responses in attempts to model the population of EREN User Group members, which totaled 1,468. Of the 40 respondents, 10 (25%) were able to specify an amount of extended cost savings realized from the use of EREN information (their study made no attempt to obtain energy savings information). The EREN Website, which actually incorporates several smaller sites that reside on several different servers, received 12,184,571 hits in 1997 (the year of the EREN study).

Although the two studies were more different than similar, there was still much to gain from review of the EREN Customer Satisfaction Survey Final Report, including the way in which the questions were posed and how the resulting data were manipulated and presented.

After reviewing the EREN report, we created the first version of the IAC Web questionnaire. Several iterations of possible questions were revised until a final set of questions was decided upon and arranged to provide the best flow of quantitative and qualitative questions. It was estimated that the 28 questions on the final version would take 5 to 15 minutes to complete, depending primarily on the level of involvement that a respondent may have had with the online technical information. The number of questions on the questionnaire was kept to a minimum in order to reduce the amount of time required by the respondent to complete it, while still posing a fair number of questions in attempts to discover as much as possible about the user and his or her experience with the sites visited.

The original intent of the Web study was to identify and question two different groups of Website visitors, previous and new visitors, to the Websites of the two centers that place technical information online: the Office of Industrial Productivity and Energy Analysis (OIPEA) at Rutgers University and Colorado State University's (CSU) IAC. Previous site visitors would be questioned by obtaining the e-mail addresses of people who had accessed these two Websites within the last several months, contacting those people, and requesting that they visit an ORNL Website to fill out an online questionnaire. New visitors would be questioned by placing links to the questionnaire on the two Websites and allowing those who wished to complete it to do so.

When the time came to obtain the e-mail addresses of previous visitors to the two Websites, two roadblocks emerged: a lack of usable e-mail addresses and a security/confidentiality issue raised by one of the IAC Website administrators. Thus, the focus of the Web study was reduced to only self-selecting new visitors to the two Websites of interest.

After hyperlinks to the questionnaire were placed on the two sites, only minimal responses were received in the initial set. To increase the response rate, an animated image was added not only to draw attention to the hyperlink itself, but also to provide an incentive for site visitors to fill out the online questionnaire. The first 30 site visitors to complete the questionnaire were offered an ASHRAE Pocket Guide, which contains useful equations, graphs, conversion factors, and the like for engineers and technicians. After the animated image was placed on the two sites, traffic increased enough to obtain 29 completed questionnaires within the available time frame of the project (about 3 months).

5.2 DATA COLLECTION DESIGN

It was originally hoped that the Web questionnaire might accumulate as many as 40 to 50 responses from users of the two Websites. However, only 29 responses were obtained in the three-month time frame available for soliciting responses, and a determination of the actual population size was not possible because of the lack of legitimate e-mail addresses and detailed site usage data. Responses would have to be accepted as they were received from new site visitors. Additionally, nonresponse could not be addressed without access to the list of previous e-mails. Losing that portion of the potential respondents had the effect of making it impossible to analyze and break down the data statistically.

To address the applicable time frame of this analysis, several factors were considered. The first completed questionnaire was received on March 20, and the 29th was received on June 24, after 96 days of availability on the two Websites. The availability of the questionnaire online was constrained by the short time period allocated for the study. It was desired that the data collected over the 96 day period be extrapolated to represent data that may have been collected for an entire year. This would result in the use of a multiplier of 3.8 (equivalent to dividing by 96 and multiplying by 365) to expand the results to one full year and a total of approximately 110 responses. Unfortunately, neither the CSU nor the Rutgers sites recorded site usage data which could be used to support the assumption that site traffic experienced for the duration of the study could be extrapolated to the entire year. Therefore, the results presented here are based solely on the responses received over the limited duration of the study.

5.3 ENERGY AND COST SAVINGS RESULTS

Section 5.3 provides the results from 8 of the 28 questions in the questionnaire. The 8 questions detailed here are all of the quantifying questions and one related qualitative question. The questions and the associated responses are presented in the same order in which they were posed in the questionnaire. The remaining 20 questions and their associated responses are presented in Appendix C.2, and a replica of the questionnaire itself is presented in Appendix C.1. Each question is stated and then followed by comments and/or interpretation and a tabular response breakdown.

For the questions answered here, several breakdowns are provided. For each quantitative question, the responses are broken down into domestic and foreign categories to separate the associated energy and cost savings reported by the users. Additionally, for the energy savings questions, two tables are presented: Table 5.1A for site savings and Table 5.1B for source savings. The source value takes the energy conversion efficiency of electricity into account and divides the site value by 0.3312 for the responses where electricity was chosen as the dominant fuel type (see the discussion on Question 7 for more information on how the chosen fuel types affected the calculated savings).

Last, out of 29 respondents, only 11 provided energy and/or cost savings information. In many of the questionnaires, at least one respondent either inadvertently or intentionally skipped a question, leaving the total number answered to less than 29. (In the following tables, totals are provided where respondents were requested to choose only one answer; where respondents were allowed to check all applicable answers, no totals are presented.)

5.3.1 Individual Results from the Questionnaire

In Question 6, Web users were asked to estimate how much annual energy savings have resulted/will result from their use of the information obtained. As the first quantitative question posed, this is the question that attempted to find out the level of direct energy savings that occurs through the use of online IAC technical information. Of the savings responses received for this question (10), the "#" column reveals the quantity of responses received per savings category, and the "%" column breaks down the percentage of responses received per savings category.

Taking the average value in each category except the last (where 1,000,000 MMBtu/yr is used) and multiplying by the number of respondents results in the values noted in the two far right columns. Totaling those two columns creates the values in the bottom right-hand corner of Table 5.1A, which is the total estimated potential site energy savings for domestic and foreign users. Using the lowest available value in the largest savings category has the effect of making the results' estimates conservative. Also, it should be noted that because of the almost daily increase in the number of people using the Web, the number of site visitors will most likely only go up in the foreseeable future.

Table 5.1B reveals the same values presented in Table 5.1A except with source energy savings in lieu of site energy savings. In both tables, the largest category sets about 99.7% of the final value for domestic and foreign savings and becomes the most important category in these savings estimates.

The reported annual domestic site savings value in Table 5.1A is just over 1 million MMBtu (or 1 trillion Btu). In comparing this potential energy savings value with the quantity of site energy savings achieved by the assessments for the IAC Program in 1997 [960,214 MMBtu (Muller 1998)], it appears that the act of placing various documents related to the IAC Program online notably extends the benefits that the IAC Program achieves through direct work with U.S. industries.

Table 5.1A. Site energy savings reported by IAC Web users.

Answer Choices	Average of	Savings Responses				Average X # Responses	
	Range - Site[a]	Domestic		Foreign		Domestic	Foreign
(MMBtu/yr)	(MMBtu/yr)	(#)	(%)	(#)	(%)	(MMBtu)	(MMBtu)
No savings OR 0	0	0	0	1	25	---	0
< 100	50	0	0	1	25	---	50
100 - 250	175	1	16.7	0	0	175	---
250 - 500	375	1	16.7	0	0	375	---
500 - 1,000	750	2	33.3	0	0	1,500	---
1,000 - 2,500	1,750	1	16.7	0	0	1,750	---
2,500 - 10,000	6,250	0	0	1	25	---	6,250
10,000 - 1,000,000	---	0	0	0	0	---	---
> 1,000,000	1,000,000[b]	1	16.7	1	25	1,000,000	1,000,000
Totals/Reported Site Energy Savings		*6*	*100*	*4*	*100*	*1,003,800*	*1,006,300*

[a] An "average of range" value was not calculated unless there were responses in that answer choice category.

[b] Conservative estimate for range provided.

Table 5.1B. Source energy savings reported by IAC Web users.

Answer	Average of	Savings Responses				Average X # Responses	
Choices	Range - Source[a,b]	Domestic		Foreign		Domestic	Foreign
(MMBtu/yr)	(MMBtu/yr)	(#)	(%)	(#)	(%)	(MMBtu)	(MMBtu)
No savings OR 0	0	0	0	1	25	---	0
< 100	151	0	0	1	25	---	151
100 - 250	528	1	16.7	0	0	528	---
250 - 500	1,132	1	16.7	0	0	1,132	---
500 - 1,000	2,264	2	33.3	0	0	4,528	---
1,000 - 2,500	5,283	1	16.7	0	0	5,283	---
2,500 - 10,000	18,869	0	0	1	25	---	18,869
10,000 - 1,000,000	---	0	0	0	0	---	---
> 1,000,000	3,019,000/ 1,000,000[c]	1	16.7	1	25	3,019,000	1,000,000
Totals/Reported Source Energy Savings		*6*	*100*	*4*	*100*	*3,030,471*	*1,019,020*

[a] An "average of range" value was not calculated unless there were responses in that answer choice category.

[b] See the discussion that accompanies Question 7 for a breakdown on how these values were calculated.

[c] Conservative estimate for range provided.

Question 7 asked Web users to identify the dominant fuel type from which their savings occurred. Clearly, the dominant type of fuel savings occurring as a result of the use of IAC online technical information is electricity, at 72% (domestic and foreign combined). However, this could be reflecting the wide variation of affiliations and organizations indicated by respondents (see Appendix C.2, Question 28), as some responses of primary savings related to fuel oil and natural gas might be expected if a larger percentage of respondents chose an industrial affiliation.

The values in Table 5.2 played an important role in calculating site versus source values in the energy savings tables in this section. When a respondent chose electricity as the dominant fuel type from which their savings were incurred, then all of their responses to the quantifying questions (site values) were multiplied by 3.019 (or divided by 0.3312) to obtain the source equivalent values. If natural gas, fuel oil, coal or "other" was chosen, then the multiplier used to obtain source from site values was 1.0 (an assumed efficiency). When "no dominant fuel type" was chosen, the associated value was assumed to be one-half electricity savings and one-half another type of fuel savings and split evenly, with half multiplied by 3.019 and half multiplied by 1.0. The resulting two values were then added back together to obtain the final source value for that original site value.

Table 5.2. Dominant fuel type identified by IAC Web users.

	Domestic Responses		Foreign Responses	
Answer Choices	(#)	(%)	(#)	(%)
Electricity	6	100	2	40
Natural gas	0	0	0	0
Fuel oil	0	0	0	0
Coal	0	0	1	20
No dominant fuel type	0	0	2	40
Other (Please specify)	0	0	0	0
Totals	*6*	*100*	*5*	*100*

In Question 8, Web users were asked to estimate how much annual cost savings have resulted/will result from the information obtained related to energy efficiency or use reduction. For the domestic savings, the response category selected the most often was the $5,000–$25,000 range (Table 5.3). The largest category clearly has the greatest impact on both the domestic and foreign estimates of savings. For the foreign savings, the totals are much smaller than the domestic savings due to the dominant fuel types (electric vs. coal) reported by the users.

Users indicated cost savings resulting from waste minimization and/or pollution prevention efforts, in Question 9. The savings fall into similar dollar ranges as the responses to Question 8, with one domestic respondent reporting savings in the largest category and two in the $5,000-$25,000 range (Table 5.4). Total domestic cost savings reported for waste minimization and pollution prevention activities are lower than those reported for energy.

Table 5.3. Energy cost savings reported by IAC Web users.

Answer Choices ($/yr)	**Average of Range[a] ($/yr)**	**Savings Responses** Domestic (#)	Domestic (%)	Foreign (#)	Foreign (%)	**Average X # Responses** Domestic ($)	Foreign ($)
No savings OR 0	0	0	0	1	20	---	0
< 100	50	0	0	1	20	---	50
100 - 500	300	1	16.7	0	0	300	---
500 - 1,000	---	0	0	0	0	---	---
1,000 - 5,000	---	0	0	0	0	---	---
5,000 - 25,000	15,000	3	50	1	20	45,000	15,000
25,000 - 100,000	62,500	1	16.7	1	20	62,500	62,500
100,000 - 1,000,000	---	0	0	0	0	---	---
> 1,000,000	13,380,000[bc]/ 1,750,000[bc]	1	16.7	1	20	13,380,000	1,750,000
Totals/Reported Energy Cost Savings		*6*	*100*	*5*	*100*	*13,487,800*	*1,827,550*

[a] An "average of range" value was not calculated unless there were responses in that answer choice category.
[b] The "average of range" values for the open-ended, largest cost category were adjusted to more accurately represent energy costs that correspond to each user's reported dominant fuel type and original claim of energy savings.
[c] The first value applies to domestic savings, the second to foreign savings.

Table 5.4. Waste minimization and pollution prevention cost savings reported by IAC Web users.

Answer Choices ($/yr)	**Average of Range[a]** ($/yr)	**Savings Responses** Domestic (#)	Domestic (%)	Foreign (#)	Foreign (%)	**Average X # Responses** Domestic ($)	Foreign ($)
No savings OR 0	0	1	16.7	1	20	0	0
< 100	50	1	16.7	1	20	50	50
100 - 500	---	0	0	0	0	---	---
500 - 1,000	---	0	0	0	0	---	---
1,000 - 5,000	---	0	0	0	0	---	---
5,000 - 25,000	15,000	2	33.3	1	20	30,000	15,000
25,000 - 100,000	62,500	1	16.7	1	20	62,500	62,500
100,000 - 1,000,000	---	0	0	0	0	---	---
> 1,000,000	1,000,000[b]	1	16.7	1	20	1,000,000	1,000,000
Totals/Reported Waste Minimization and Pollution Prevention Cost Savings		*6*	*100*	*4*	*100*	*1,092,550*	*1,077,550*

[a] An "average of range" value was not calculated unless there were responses in that answer choice category.
[b] Conservative estimate for range provided.

Question 10 asked Web users to estimate how much annual cost savings have resulted or will result from the information obtained related to increasing productivity. According to Table 5.5, productivity cost savings reported by domestic users are on the same order as savings reported for domestic waste minimization activities, but are significantly lower than reported energy cost savings.

Table 5.5. Productivity cost savings reported by IAC Web users.

Answer Choices	**Average of Range**[a]	**Savings Responses**				**Average X # Responses**	
		Domestic		Foreign		Domestic	Foreign
($/yr)	($/yr)	(#)	(%)	(#)	(%)	($)	($)
No savings OR 0	0	0	0	1	25	0	0
< 100	50	1	16.7	1	25	50	50
100 - 500	---	0	0	0	0	---	---
500 - 1,000	750	1	16.7	0	0	750	---
1,000 - 5,000	---	0	0	0	0	---	---
5,000 - 25,000	15,000	1	16.7	1	25	15,000	15,000
25,000 - 100,000	62,500	2	33.3	0	0	125,000	---
100,000 - 1,000,000	550,000	0	0	1	25	---	550,000
> 1,000,000	1,000,000[b]	1	16.7	0	0	1,000,000	---
Totals/Reported Productivity Cost Savings		*6*	*100*	*4*	*100*	*1,140,800*	*565,050*

[a] An "average of range" value was not calculated unless there were responses in that answer choice category.

[b] Conservative estimate for range provided.

Additionally, foreign-reported cost savings from productivity efforts were nearly half the savings generated by foreign waste minimization actions and only a third of those from energy-related activities. Based on these results, it seems that Web users are currently receiving the most benefit from IAC Website materials on energy-efficiency and conservation.

In Question 11, Web users were asked if any of the measures or ideas implemented were replicated elsewhere within their facility, company, or by other plants, and if so, they were asked to estimate the annual energy savings. Note that the results are split into site and source savings and are shown respectively in Tables 5.6A and 5.6B. Once again, the largest category dominates the results, as users claim to have replicated energy savings of over 1,000,000 MMBtu. In this case, however, foreign users claim more savings due to replication, than they claim for original site and source energy savings.

Table 5.6A. Replicated site energy savings reported by IAC Web users.

Answer Choices (MMBtu/yr)	**Average of Range - Site**[a] (MMBtu/yr)	**Savings Responses** Domestic (#)	Domestic (%)	Foreign (#)	Foreign (%)	**Average X # Responses** Domestic (MMBtu)	Foreign (MMBtu)
No savings OR 0	0	4	66.7	1	20	0	0
< 100	---	0	0	0	0	---	---
100 - 250	175	0	0	1	20	---	175
250 - 500	375	0	0	1	20	---	375
500 - 1,000	---	0	0	0	0	---	---
1,000 - 2,500	1,750	1	16.7	0	0	1,750	---
2,500 - 10,000	---	0	0	0	0	---	---
10,000 - 1,000,000	---	0	0	0	0	---	---
> 1,000,000	1,000,000[b]	1	16.7	2	40	1,000,000	2,000,000
Totals/Reported Replicated Site Energy Savings		*6*	*100*	*5*	*100*	*1,001,750*	*2,000,550*

[a] An "average of range" value was not calculated unless there were responses in that answer choice category.

[b] Conservative estimate for range provided.

Table 5.6B. Replicated source energy savings reported by IAC Web users.

Answer Choices (MMBtu/yr)	**Average of Range - Source**[a,b] (MMBtu/yr)	**Savings Responses** Domestic (#)	Domestic (%)	Foreign (#)	Foreign (%)	**Average X # Responses** Domestic (MMBtu)	Foreign (MMBtu)
No savings OR 0	0	4	66.7	1	20	0	0
< 100	---	0	0	0	0	---	---
100 - 250	528	0	0	1	20	---	528
250 - 500	754	0	0	1	20	---	754
500 - 1,000	---	0	0	0	0	---	---
1,000 - 2,500	5,283	1	16.7	0	0	5,283	---
2,500 - 10,000	---	0	0	0	0	---	---
10,000 - 1,000,000	---	0	0	0	0	---	---
> 1,000,000	3,019,000/ 2,009,500[c,d]	1	16.7	2	40	3,019,000	4,019,000
Totals/Reported Replicated Source Energy Savings		*6*	*100*	*5*	*100*	*3,024,283*	*4,020,282*

[a] An "average of range" value was not calculated unless there were responses in that answer choice category.

[b] See the discussion that accompanies Question #7 for a breakdown on how these values were calculated.

[c] The first value applies to domestic savings, the second to foreign savings.

[d] Conservative estimate for range provided.

Web users were asked, in Question 12, to estimate how much annual cost savings have resulted or will result from the replicated savings. This question is an extension of Question 11 and asks for an estimate of the cost savings associated with the energy savings the respondent provided in that question. Replicated cost savings reported by domestic users are slightly higher than original energy savings, where as replicated cost savings reported by foreign users are eight times larger.

This question should be expanded in future questionnaires to include an estimate of savings achieved from replication of waste minimization and/or pollution prevention and productivity measures (Table 5.7), information which was not captured in this questionnaire.

Table 5.7. Replicated energy cost savings.

Answer Choices	**Average of Range**[a]	**Savings Responses**				**Average X # Responses**	
		Domestic		Foreign		Domestic	Foreign
($/yr)	($/yr)	(#)	(%)	(#)	(%)	($)	($)
No savings OR 0	0	4	66.7	1	20	0	0
< 100	---	0	0	0	0	---	---
100 - 500	300	0	0	1	20	---	300
500 - 1,000	---	0	0	0	0	---	---
1,000 - 5,000	3,000	1	16.7	1	20	3,000	3,000
5,000 - 25,000	---	0	0	0	0	---	---
25,000 - 100,000	---	0	0	0	0	---	---
100,000 - 1,000,000	---	0	0	0	0	---	---
> 1,000,000	13,380,000/ 7,565,000[bc]	1	16.7	2	40	13,380,000	15,130,000
Totals/Reported Replicated Energy Cost Savings		*6*	*100*	*5*	*100*	*13,383,000*	*15,133,300*

[a] An "average of range" value was not calculated unless there were responses in that answer choice category.
[b] The "average of range" values for the open-ended, largest cost category were adjusted to more accurately represent energy costs that correspond to each user's reported dominant fuel type and original claim of energy savings.
[c] The first value applies to domestic savings, the second to foreign savings.

In Question 13, Web users claiming energy and/or cost savings resulting from the use of IAC information were asked if they were still realizing those savings, and if not, would they estimate the length of time that savings were actually experienced. The results of this question signify that 83% of the domestic respondents are achieving energy or cost savings that last at least more than one year (Table 5.8). As time passes on, it would be of interest to collect additional data on savings persistence as experienced by IAC Web users as they establish a history of savings from the use of IAC Web-based information.

Table 5.8. Savings persistence reported by IAC Web users.

Answer Choices	Domestic Savings Responses		Foreign Savings Responses	
	(#)	(%)	(#)	(%)
A. Energy Savings				
Yes	5	83.3	2	50
No	0	0	1	25
- If no, length savings achieved	---	---	1 year	---
No savings achieved	1	16.7	1	25
Totals for question 12 - part A	*6*	*100*	*4*	*100*
B. Cost Savings				
Yes	5	83.3	2	50
No	0	0	1	25
- If no, length savings achieved	---	---	1 year	---
No savings achieved	1	16.7	1	25
Totals for question 12 - part B	*6*	*100*	*4*	*100*

5.3.2 Summary Results from the Web Questionnaire

Aggregating the individual results shown in Sect. 5.3.1 generates the following summary of the estimates of IAC Program savings from the Web study. Tables 5.9A and 5.9B present the site and source energy saving totals, while Table 5.10 presents the cost saving totals.

Table 5.9A. Site summary energy savings reported by IAC Web users.

Savings Categories Reported (96 days)	Direct (MMBtu)	Replicated (MMBtu)	Total (MMBtu)
Domestic	1,003,800	1,001,750	2,005,550
Foreign	1,006,300	2,000,550	3,006,850
Total	2,010,100	3,002,300	5,012,400

Table 5.9B. Source summary energy savings reported by IAC Web users.

Savings Categories Reported (96 days)	Direct (MMBtu)	Replicated (MMBtu)	Total (MMBtu)
Domestic	3,030,471	3,024,283	6,054,754
Foreign	1,019,020	4,020,282	5,039,302
Total	4,049,491	7,044,565	11,094,056

Table 5.10. Summary cost savings reported by IAC Web users.

Savings Categories Reported (96 days)	Energy ($)	WM/PP[a] ($)	Productivity ($)	Replicated Energy ($)	Total ($)
Domestic	13,487,800	1,092,550	1,140,800	13,383,000	29,104,150
Foreign	1,827,550	1,077,550	565,050	15,133,300	18,603,450
Total	15,315,350	2,170,100	1,705,850	28,516,300	47,707,600

[a] Waste minimization/pollution prevention.

Table 5.9B reveals that over 11 million MMBtu (or 11 trillion Btu) in total source energy savings are generated through the attainment and utilization of online IAC technical information, with approximately 55% of that coming from domestically realized savings (6 million MMBtu). Note that this estimate considers the input (source) energy required to generate the output (site) energy; the site savings are shown in Table 5.9A. Domestic site energy savings by Web users were over 2 million MMBtu (or 2 trillion Btu). By comparison with the implemented site energy savings generated directly by new 1997 IAC assessments alone (960,214 MMBtu), the Web study indicates that evidently there is the potential to greatly extend the benefits that the IAC Program provides through placing program-related information online. Work done to further support this effort would not only contribute to the success of the program but would also help produce tremendous energy savings both domestically and elsewhere.

Table 5.10 reveals that $47.7 million in total costs are saved annually through the use of the online IAC technical information, with over 60% of those savings coming from U.S.-based companies and organizations. By comparison to the total cost savings realized by implemented measures from new 1997 IAC assessments alone ($36,942,937), again, the program should recognize the benefits associated with placing program-related information online and work to improve this program strength.

5.4 QUALITY ASSURANCE/QUALITY CONTROL

Of the total 29 respondents, 12 originally provided quantitative information on energy and cost savings already realized or projected to be realized. Of those 12, over 99% of the total savings were accounted for by four "big fish," or respondents who reported on several quantitative questions the largest available categories for energy and/or cost savings. Additionally, of those four, the largest three were domestically based users, with the smallest big fish foreign-based. Because these three respondents accounted for such a large portion of the domestic results, we attempted to contact them in order to obtain more information on

- whether their reported savings were already realized or future projections,
- whether these were estimates or calculated savings,
- what IAC documents were being used, and
- how the information in those documents was being used.

With additional data from follow-up efforts, it was determined that two of the three achieved defensible savings, and only one of those two actually produced domestic savings. Of the three domestic users contacted, one provided ample evidence to support domestic savings, one clarified that although he was presently working in the United States, the savings he reported were actually from measures implemented in New Zealand. The last user was unable to support his claims of savings (and was subsequently removed from the savings analysis).

The remaining valid domestic user just happened to be the biggest of the four big fish, and provided helpful insight into his use of IAC information. The respondent noted that “the savings I was stating are a combination of savings realized and about to be realized by the industrial clients [for whom] I have been providing services.” The respondent went on to describe his experience with a particular manufacturing facility and how they were able to recommend productivity, energy, and waste stream-based savings for that facility through the use of three of Rutgers training manuals and the IAC database. Particularly, he noted, “We were able to realize an improvement of 41% in process flow..., without an increase in energy use, a decrease from 9% to 3% in wasted product..., and a 3% improvement in employee effectiveness. The payback was phenomenal.”

5.5 DECISION MODEL RESULTS

IAC Web-based information also appears to positively impact the users’ EE decision making in a way similar to the results related to client assessments and alumni influences upon their employers, albeit to a lesser degree. Figures 5.1 and 5.2 illustrate that the frequency both of identifying and of implementing energy saving opportunities increased after using Web-based information. Neither statistical result is highly significant, however. T-test significance levels are 0.10 and 0.20, respectively.

Figure 5.3 indicates that there is a positive change in the stage in the EE life cycle model after using IAC Web-based information. Again, the magnitude of the change is less than the changes witnessed by clients and alumni employers. Additionally, the change is not statistically significant, with a significance level of 0.15 for the T-test.

Last, payback rates did not change significantly before and after use of Web-based information, as indicated in Fig. 5.4. This result is also similar to the client and alumni findings.

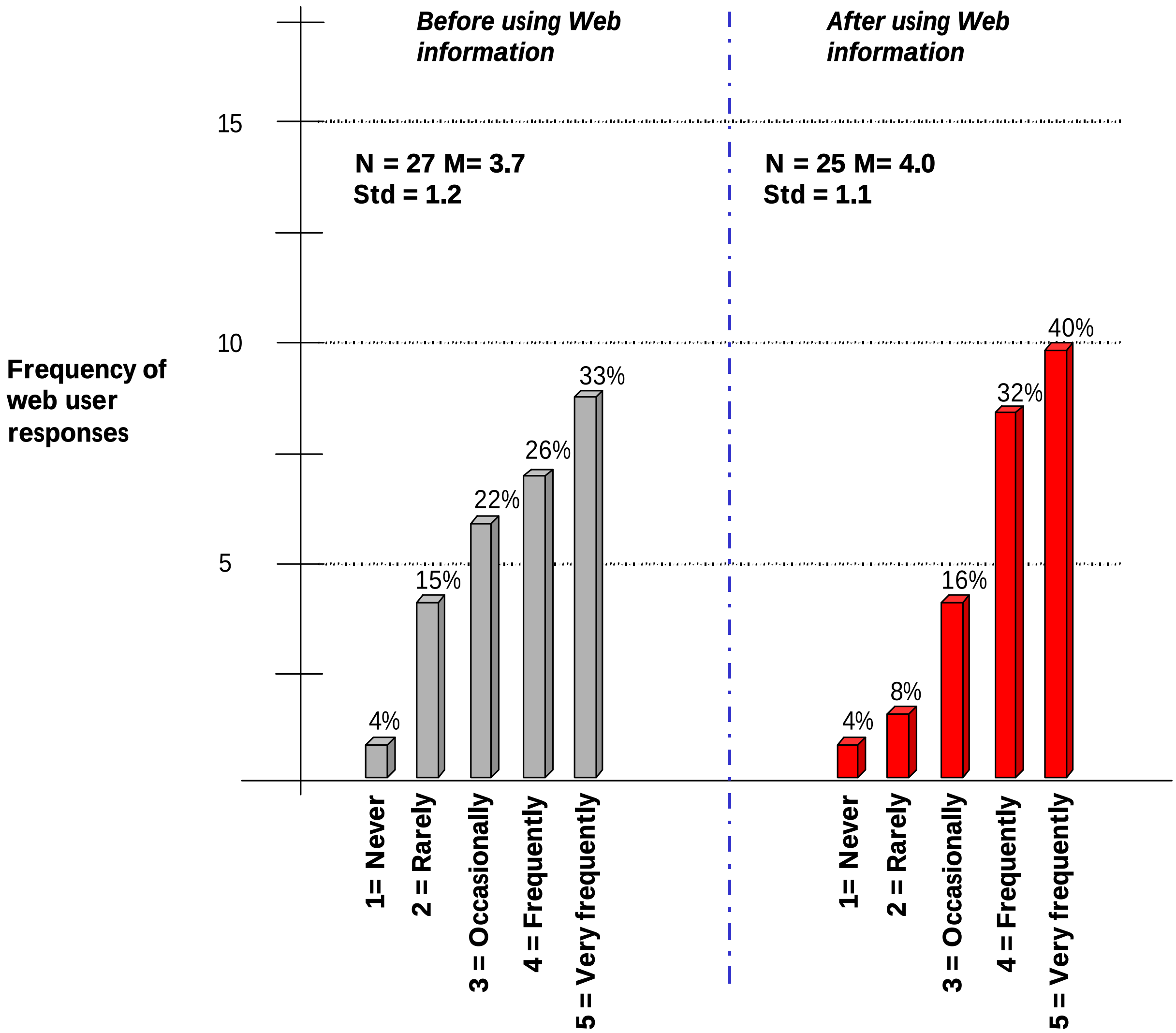

Fig. 5.1. Frequency of energy savings opportunities identified before and after using IAC Web-based information.

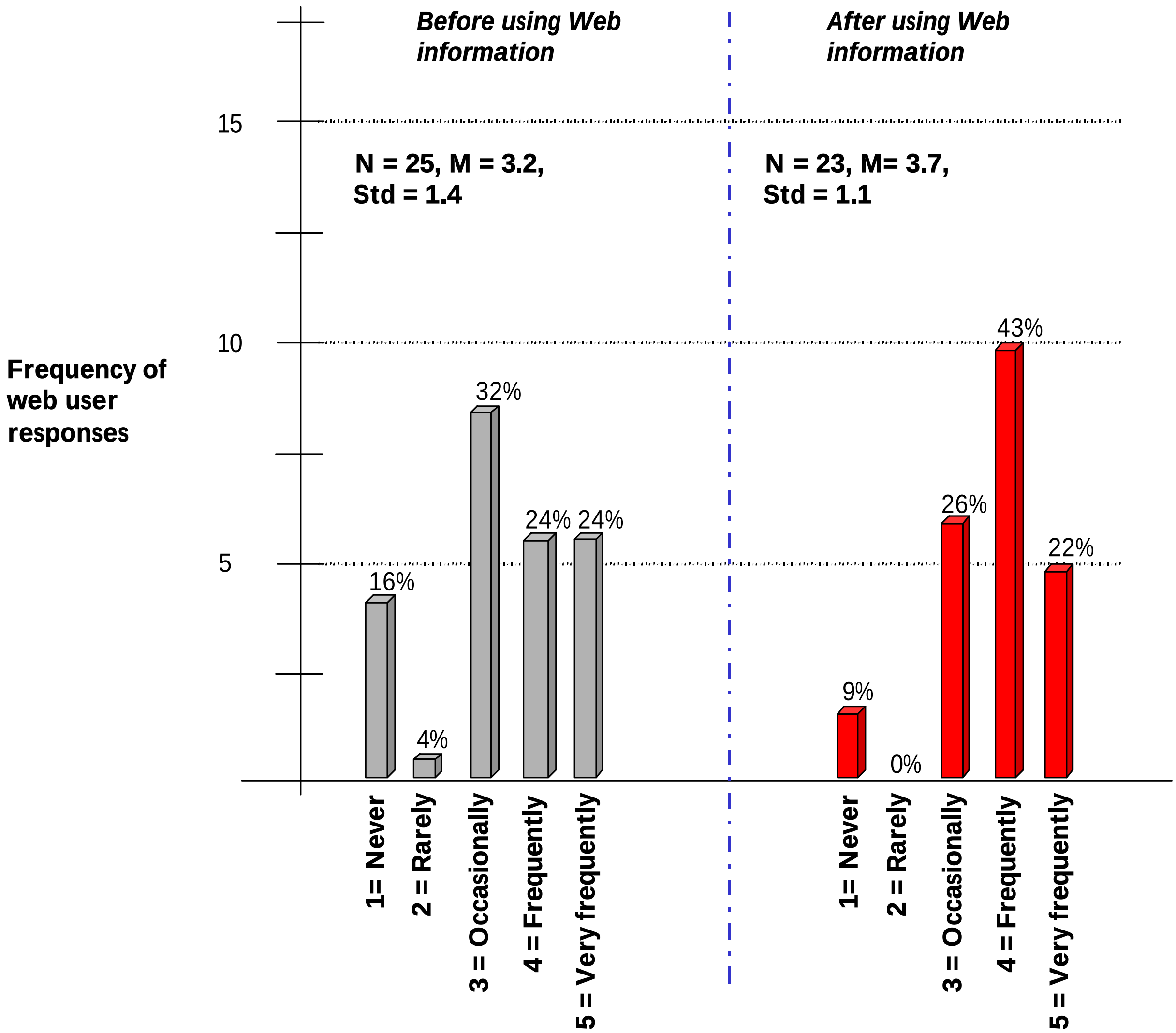

Fig. 5.2. Frequency of energy savings opportunities implemented before and after using IAC Web-based information.

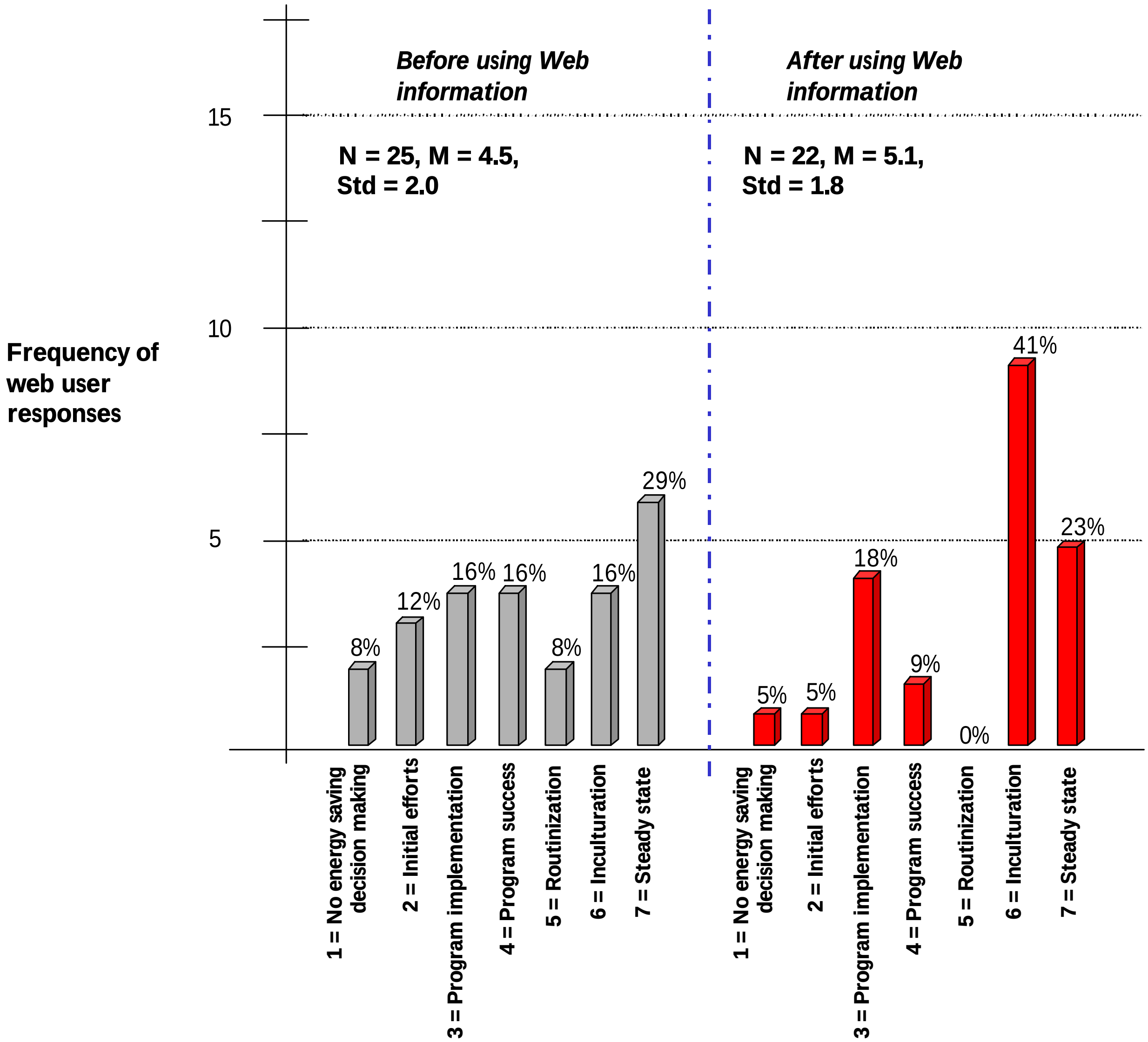

Fig. 5.3. Stages in the life cycle model of industrial energy efficiency decision making for organizations before and after using IAC Web information.

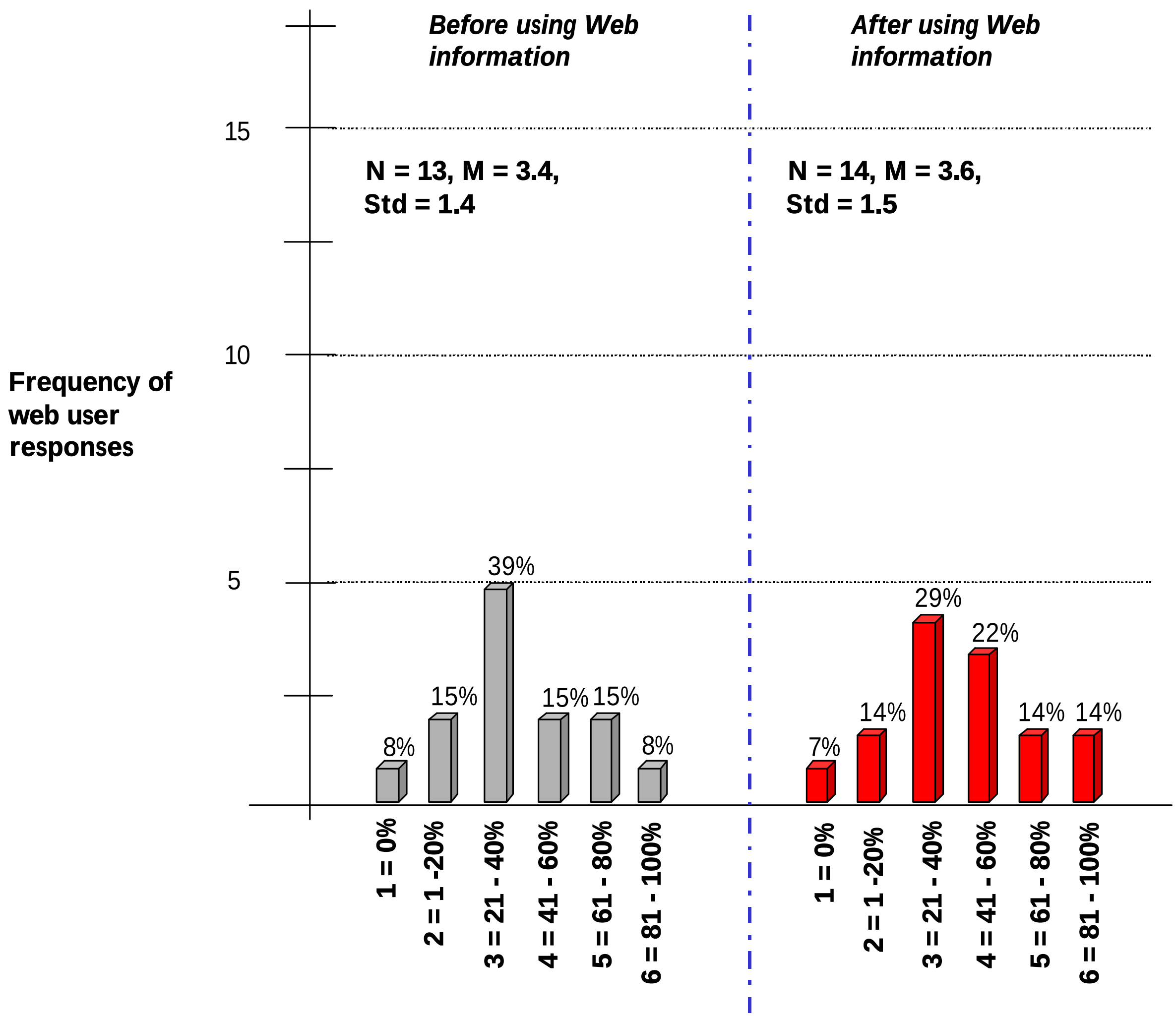

Fig. 5.4. Percentage of energy savings investments with payback performance of 2 years or less before and after organizations use IAC Web information.

5.6 RECOMMENDATIONS

On the basis of the results of the Web study, we suggest consideration of the following recommendations:

< Because the use of the Web as a place for information transfer is likely to increase in the foreseeable future, the IAC Program should continue to use the Web study to monitor the usefulness of the online information as well as to obtain more accurate information about online technical information usage patterns. Through a regular review of the collected information, the IAC Program will be able to respond to the needs and or desires of its online users and increase the associated savings realized. Additionally, the program will be able to find out what kind of information users are looking for and create new documents that present information specifically addressing user information requests.

< With regard to the questionnaire itself, we have a couple of recommendations. First, it would be helpful to realign some of the answer categories to allow for more accurate information gathering. For example, more high-end categories should be created. Because the largest category of energy or cost savings was >1,000,000, the questionnaire was not able to distinguish between those realizing $2 million in cost savings and those realizing $5 million in cost savings, for example. (Estimates were developed based on the users claim of energy cost savings, dominant fuel type, and typical fuel costs.) Second, because some anomalies in the data have been noted, space should be provided at the end of every question to allow room for a respondent to explain his or her reasoning for a particular response.

< We also note two recommendations with regard to the IAC Websites. First, given the results that are seen from this study, more centers should become involved in placing examples of previous recommendations online and/or creating documents that exploit the good that their years of regional service have provided. It is very possible that the creation and dissemination of such information could significantly magnify the program’s energy and cost savings. Second, each site should utilize a tracking service that allows more information to be obtained on the visitors that are perusing the sites. For example, those who wish to download information might be required to fill out either this or another questionnaire first, or the program might create an IAC users’ group similar to the EREN users’ group.

6. INTEGRATED RESULTS AND CONCLUSIONS

In this section preliminary cost and energy annual and lifetime savings estimates are computed for FY 1997 assessments. This is done by adjusting FY 1997 totals from the IAC database using estimates for CBRs from Sect. 3 (OIT 1999b). These cost and energy savings are discussed in Sect. 6.1. In Sect. 6.2, annual savings estimates for the assessment pathway are combined with the annual savings estimates for the alumni pathway and Website pathways, to produce overall annual savings estimates for the three pathways. Aggregate and comparative results with respect to the EE decision-making model are discussed in Sect. 6.3. Caveats and conclusions are in Sect. 6.4, along with suggestions for future work.

6.1. ENERGY AND COST SAVINGS FOR FY97 ASSESSMENTS

In this section, cost and energy savings estimates associated with FY 1997 assessments are computed from IAC database totals adjusted, using the CBRs estimated in Sect. 3, to estimate actual savings. Because the client follow-up is a pilot study, savings estimates based on it must be regarded as preliminary.

The latest published IAC database totals for the savings from assessments are for FY 1997 (OIT 1999b). Tables 6.1A and 6.1B contain the FY 1997 energy and cost database totals.

Table 6.1A. FY 1997 IAC assessment energy savings (OIT 1999b).

Energy Type	Savings (MMBtu)
Site Electric	392,793
Other (Site)	567,421
Total Site Energy	**960,214**
Source Electric (Site Electric × 3.019)	1,185,842
Other (Site = Source)	567,421
Total Source Energy	**1,753,263**

Table 6.1B. FY 1997 IAC assessment cost savings (OIT 1999b).

AR Type	Savings ($)
Energy	9,290,838
Waste	5,198,095
Productivity	22,454,004
All	36,942,937

Comprehensive savings estimates can be computed from these original IAC estimates using the FY 1993–1997 CBRs in Table 3.3 and additional CBRs, which are assumed here because the pilot client follow-up goes back only to FY 1993 (6 years before the effort).[1] Because the pilot study suggests that CBRs for assessments

[1]The FY92 CBRs in Table 3.3, which are based on the response of a single client, are unreliable.

conducted 6 years before the survey are still in the neighborhood of 1.0, and because it is unlikely that benefits would be truncated exactly 6 years after the assessment, additional CBR values are assumed to degrade linearly for FY 1988–1992: 0.2, 0.4, 0.6, 0.8, and 1.0, respectively. The assumed values should be validated or revised through a full-scale effort. An additional CBR of 1.0 is also assumed for FY 1998—that is, for one fiscal year before the client follow-up. The estimated and assumed cost- and energy-basis CBRs are in given Table 6.2.

Table 6.2. Estimated and assumed FY-specific CBRs.

FY of Assessment	Follow-up FY (1999) & Assessment FY	Energy, Waste, and Productivity Cost CBR	Site Energy CBR	Source Energy CBR
1988 (assumed)	11	0.20	0.20	0.20
1989 (assumed)	10	0.40	0.40	0.40
1990 (assumed)	9	0.60	0.60	0.60
1991 (assumed)	8	0.80	0.80	0.80
1992 (assumed)	7	1.00	1.00	1.00
1993	6	1.37	0.98	1.19
1994	5	0.90	0.87	0.93
1995	4	1.45	1.06	0.98
1996	3	1.04	1.33	1.31
1997	2	1.01	1.12	1.01
1998 (assumed)	1	1.00	1.00	1.00

Table 6.2 also contains entries for "Follow-up FY (1999) & Assessment FY." Under the time-invariance assumption discussed in Sect. 2.1, these entries determine the appropriate CBR for computing, using Eq. 2.2, FY 1997 savings accrued 1, 2, 3, etc., years from the FY 1997 assessment, that is, in FY 1998, FY 1999, FY 2000, etc. Using the CBRs from Table 6.2, the total site and source energy savings and cost savings in Tables 6.1A and 6.1B can be adjusted to reflect actual savings for FY 1997. Although the cost estimates in Table 6.1B are listed by AR category, it is not feasible to adjust the AR type-specific savings because of statistical limitations of the CBRs and the pilot study data (i.e., too few waste and productivity ARs; see Sect. 3.4.2). The FY-specific CBRs are themselves quite variable, but statistical errors based on them are more likely to average out in the totals. Tables 6.1A and 6.1B and Table 6.2 are combined in Table 6.3 to produce savings estimates for FY 1997 assessments, by fiscal year from the assessment (FY 1998, FY 1999, etc.), and for total lifetime savings. The FYs are also listed.

Table 6.3. Savings estimates for FY 1997 assessments by year from assessment.

Year from FY 1997 Assessment	FY	Cost ($) Saved During Year	Site Energy (MMBtu) Saved During Year	Source Energy (MMBtu) Saved During Year
1	1998	36,942,937	960,214	1,753,263
2	1999	37,312,366	1,075,440	1,770,796
3	2000	38,420,654	1,277,085	2,296,775
4	2001	53,567,259	1,017,827	1,718,198
5	2002	33,248,643	835,386	1,630,535
6	2003	50,611,824	941,010	2,086,383
7	2004	36,942,937	960,214	1,753,263
8	2005	29,554,350	768,171	1,402,610
9	2006	22,165,762	576,128	1,051,958
10	2007	14,777,175	384,086	701,305
11	2008	7,388,587	192,043	350,653
Lifetime	All	360,932,494	8,987,603	16,515,737

6.2. ANNUAL SAVINGS ESTIMATES COMBINED OVER PATHWAYS

In Table 6.4, annual savings estimates for FY 1997 assessments from Table 6.3 are combined with annual savings estimates from the alumni and Website studies. Because the alumni and Website savings estimates are annual (not lifetime), annual estimates are computed for assessments too, though this is a departure from Sect. 6.1. How should annual savings be defined for assessments? Here, for the purpose of illustration (not recommendation), they are computed from the CBR average for FY 1993–97, from Table 6.2, because these are the years for which pilot client study data are available.

The alumni pathway savings estimates in Table 6.4 are from the FY 1997 entries in Tables 4.2 to 4.4. The alumni estimates are the averages of the Assumption 2 energy savings upper and lower bounds. The Website entries in Table 6.4 are the reported domestic totals from Table 5.9B and Table 5.10. These figures are current, that is, for the current year—approximately FY 1999. FY 1997 Website data was not collected. Because of the increasing use of the Internet, the FY 1999 Website data was likely to overestimate Web-based savings for FY 1997, though by the same token, the FY 1999 data are likely to underestimate Website savings for future years. As an approximation, the Website results are used here to estimate FY 1997 Website savings, so that combined-pathway savings estimates can be illustrated. Total savings estimates combined over pathways must be regarded in the context of this approximation as well as the preliminary nature of the results from the client follow-up.

From Table 6.4, the total annual cost savings attributable to the IAC Program by the assessment, alumni, and Website pathways is $138,386,299. The total source energy savings is 11,323 BBtu. These are *annual* estimates. The method of accounting for lifetime assessment-generated savings in Table 6.3 might be applied to the alumni or Website pathways, but that approach is not pursued here.

Additional data could be collected to investigate persistence assumptions for extending the alumni and Website annual savings to lifetime estimates. (Note: The Website savings are not annualized because of uncertainties in the assumptions needed to justify extrapolation of the results collected for the 96-day duration of the questionnaire to a complete year.)

Table 6.4 is meant to be a side-by-side illustration of the potential impacts of the three pathways, and is based on specific, conservative interpretations of the data from the three studies. Because of the limitations set forth by the data that were available for the study, flexibility in interpretation is feasible. Alternative interpretations, however, must consider all of the evidence, as documented in Sects. 3, 4, and 5 of this report.

Table 6.4 Estimated IAC Program annual savings for FY 1997—assessment, alumni, and Website pathways

Program Component	Source Energy Savings (BBtu)	Energy Cost Savings	Total Cost Savings
Assessments	1,901	$9,237,630	$42,632,149
Alumni	3,368	$56,000,000	$66,650,000
Websites[a]	6,054	$26,870,800	$29,104,150
Total	11,323	$92,198,430	$138,386,299

[a] Domestic savings only

6.3 DECISION-MAKING MODEL

Each questionnaire contained questions pertaining to the life cycle model set out in Fig. 2.1. These questions addressed the frequency with which clients, alumni employers, and Web-information-using organizations both identify and implement energy savings opportunities. Generally, the more frequently these organizations undertake these activities, the further along the life cycle process they will be. This project was specifically interested in changes in life cycle stages before and after assessments, the arrival of alumni, and the use of Web-based IAC technical information, respectively.

Figure 6.1 indicates that in each case, IAC Program interventions are positively correlated with changes in the stage of the life cycle. For example, before an IAC assessment, the average client fell somewhere between the EE program implementation stage (3) and the EE program effects stage (4). After the assessment, the average client moved one stage ahead in the life cycle, falling somewhere between EE program direct effects (4) and routinization of the EE program (5). The alumni employers display almost exactly the same behavior. The Website users appear to have been further along the life cycle before using the IAC information and even further ahead after using the information. The average stage in the life cycle model found in this study compares favorably with the findings in the literature cited in Sect. 2.2, indicating that much has been done but much needs to be done to change energy-efficiency decision making and practices. All these changes in life cycle stages are statistically significant. Thus, these results suggest that the IAC Program has significantly and positively impacted

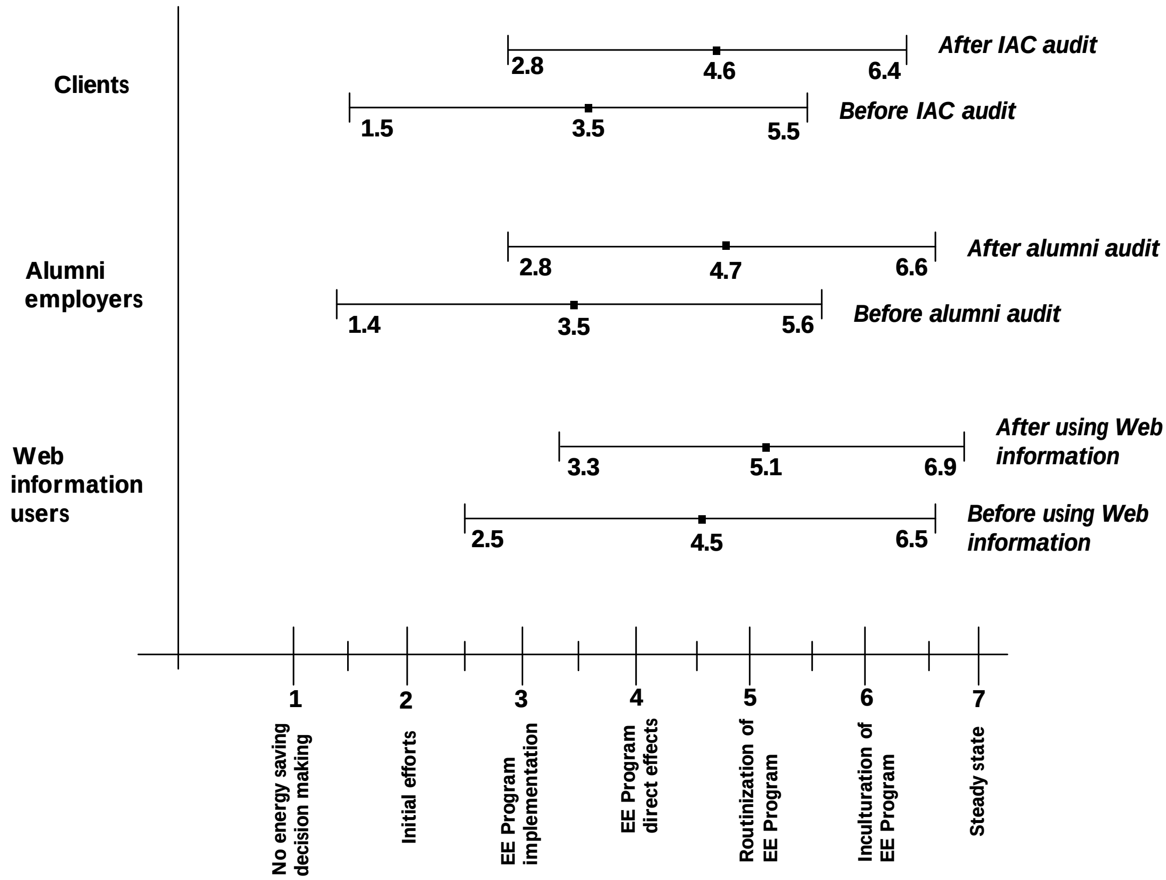

Fig. 6.1. Comparison of progression in life cycle among clients, alumni employers, and Web information users (mean and one standard deviation ranges).

participating firms' energy decision making in a lasting and permanent manner. A second conclusion is that the more direct the intervention (e.g., an industrial assessment with recommendations), the bigger the impact upon decision making the program will have.

Also explored was whether the payback rates for energy savings investments improved after an IAC Program intervention. Each questionnaire asked what percentage of investments provided payback rates of less than 2 years, before and after the intervention. As shown in Fig. 6.2, in each case, the percentage of investments yielding paybacks of 2 years or less increased after the IAC Program intervention. Although positive, these changes were not statistically significant in any case. These results indicate that many firms may be making longer-term, possibly more research- oriented, investments. More research would be needed to clarify whether IAC Program interventions increased the rate of return on all investments, regardless of their payback periods.

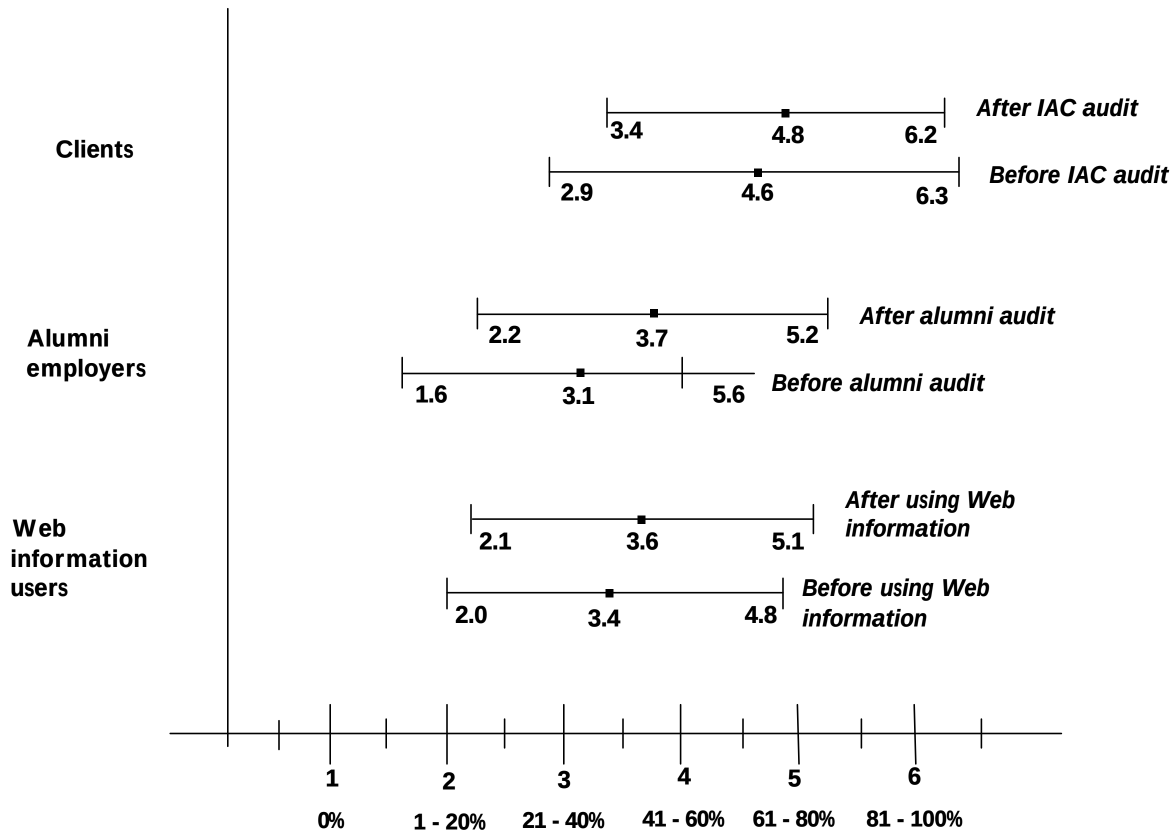

Fig. 6.2. Comparison of changes in payback rates of 2 years or less among clients, alumni employers, and Web information users (mean and one standard deviation ranges).

6.4 OBSERVATIONS AND RECOMMENDATIONS

This study leads us to numerous observations and recommendations. The first observation is that the follow-up methods used in this project were successful in collecting information both to evaluate the impacts of the IAC Program and to generate performance metrics needed to meet the requirements of GPRA. Client and alumni reactions to follow-up efforts were positive, and responses to the Web-users' questionnaire exceeded expectations.

The second observation is that the IAC Program is having many positive impacts through its use of these three pathways. The energy and cost savings attributable to the IAC Program are appreciable. Savings associated with waste reductions and productivity enhancements are increasing over time. Every so often, extraordinary savings are achieved. This was seen in both the alumni and Web-users' data.

It needs to be noted that the client follow-up was indeed a pilot study. Therefore, it is recommended that the pilot study be extended to a full-scale study to improve the statistical precision of the CBR estimates for FY 1993–1997 and to examine savings persistence by extending the time range to earlier FYs. Analysis of client data should also be performed on an annual basis to revise FY-specific CBRs (i.e., CBRs specific for years subsequent to assessments) and to check the assumption that CBRs depend on time only through time from the assessment (time invariance). Because Website questionnaires are inexpensive, the Website data collection and summarization procedure should be automated and continued to be analyzed on an annual basis. Future Website results could then be made synchronous with assessment-generated savings. Alumni follow-ups should also be administered annually, and could be Web-based (e.g., on-line exit interviews) or available via electronic mail. Using the methods developed here, future client, alumni, and Website questionnaires and data analysis can be mechanized into an efficient process for regularly determining performance metrics as well as program quality assurance.

Last, the life cycle model offers insights into how to quantitatively measure benefits of the IAC Program, and how to identify appropriate IAC and/or OIT products for IAC clients on an individual basis. For discussion, here are some potential benefits the evaluation should consider:

- estimate energy and cost savings associated with moving from one stage to the next in the EE decision-making model illustrated in Fig. ES.1.;
- work to better understand which IAC and OIT products are most appropriate for firms at different stages of the model illustrated in Fig. ES.1 and develop new program elements (e.g., executive training courses) as appropriate; and
- conduct research to better understand how firms currently make EE decisions and identify IAC and OIT elements that can help overcome deficiencies in this type of decision making—e.g., specifically evaluate why recommended measures with paybacks of 2 years have implementation rates of less than 50%.

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APPENDIX A. CLIENT SURVEY, MISCELLANEOUS RESPONSES, AND CHARACTERISTICS OF RESPONDENTS

CONTENTS

A.1 IAC METRICS EVALUATION CLIENT FOLLOW-UP QUESTIONNAIRE

The client questionnaire is broken into six components:

- introduction and opening statement,
- review of previously implemented and unimplemented assessment recommendations (ARs),
- review of internally and externally replicated ARs,
- review of alternative client activities (IAC influenced),
- customer satisfaction issues, and
- review of client decision-making practices.

The results collected from questions on ARs, replication of ARs, and decision-making practices were presented in Sect. 3 of this report. The results collected from the review of alternative client activities, customer satisfaction questions, and characteristic information on the participating clients are summarized in this appendix in Tables A.1 through A.5 and in Figs. A.1 through A.3. A discussion of these latter issues accompanies the tables and figures.

IAC METRICS EVALUATION CLIENT FOLLOW-UP QUESTIONNAIRE
March 2, 1999
Oak Ridge National Laboratory

OPENING STATEMENT:

I am working in cooperation with the University of ___________ and the U.S. Department of Energy on a follow-up study of clients of the university's Industrial Assessment Center. Your company received an assessment from the IAC in ____ (date), that provided recommendations for saving energy, <<reducing waste, and improving productivity>>. The purpose of this questionnaire is to determine how your company has utilized the assessment report and its recommendations. <<Verify knowledge/appropriateness of interviewee>> Your company received a follow-up phone call approximately one year following________________(U's) visit. At that time your representative told us the status of the recommendations provided, for example whether they were implemented, rejected, or scheduled to be implemented. I would like to verify the status of those original recommendations, and record any other actions you may have taken as a result of your experience with the IAC. This questionnaire should take 20-30 minutes of your time.

According to our records, you received __ recommendations regarding energy, __ in waste, and __ in productivity.

BODY OF QUESTIONNAIRE:

Based on the follow-up interview conducted in 199_, your representative reported the following recommendations as being implemented:

1)
2)
3)
4)
5)

Q1. I'd like to get some information about each of these implemented recommendations.

1.1 Recommendation:____

1.1a Is this still implemented? ***Y N***

IF NO

1.1b Why was it decommissioned?

1.1c When was it decommissioned? *Date*

1.1d The original estimate for annual cost savings was $_____, [did you achieve ***or*** do you think that you are still achieving] this cost savings? ***Y N***

1.1e If not, what is your estimate? *(+/- %)* (may be impacted by energy rates)

1.1f (Energy Only) The original estimate for annual <<fuel type>> energy savings was <<______ Energy Savings per Year>>, [did you achieve ***or*** do you think that you are still achieving] this energy savings? ***Y N***

1.1g If not, what is your estimate? *(+/- %)*

Conversely, the following recommendations were reported as not implemented:

1)
2)
3)
4)
5)

Q2. I'd like to ask you about these unimplemented recommendations.

2.1 Recommendation: ____

2.1a Have you implemented this recommendation? ***Y N***

IF NO go to next recommendation or Q3.

IF YES :

2.1b When was it implemented? *Date*

2.1c Is it still implemented? ***Y N***

IF YES:

2.1d The original estimate for annual cost savings was $_____, do you think that you are still achieving this cost savings? ***Y N***

2.1e If not, what is your estimate? *(+/- %)* (may be impacted by energy rates)

2.1f (Energy Only) The original estimate for annual <<fuel type>> energy savings was <<Energy Savings per Year>>, do you think that you are still achieving this energy savings? ***Y N***

2.1g If not, what is your estimate? *(+/- %)*

IF NO:

2.1h If not, why was it decommissioned?

2.1i If not, when was it decommissioned? *Date*

Q3. Were any of the measures suggested in the IAC report applied elsewhere within your plant? *Y N*

IF NO go to Q4

IF YES:

3.1a What was the measure? *Description (match w/ ARC)*

3.1b When was this measure implemented? *Date*

3.1c Is it still implemented? ***Y N***

3.1d If not, why was it decommissioned?

3.1e If not, when was it decommissioned? *Date*
3.1f Was this an energy, waste, or productivity measure (choose one)? **E W P**
3.1g What would you estimate the annual cost savings of this measure to be?
($,$$$ per year; suggest original estimate of $______ /yr for client reference)

3.1h (Energy Only) Please indicate the source of energy conserved from the following:
Electricity Natural Gas Fuel Oil Coal Other

3.1i What would you estimate the annual energy savings of this measure to be?
(*Suggest original estimate of ____________ if prompting is needed).*

Q4. Were any of the measures suggested in the IAC report implemented at other facilities, such as a sister plant? ***Y N***

IF NO go to Q5
IF YES: (for each measure)
4.1 What was the measure? *Description (match w/ ARC)*

4.1a When was this measure implemented? *Date*
4.1b Is it still implemented? ***Y N***
4.1c If not, when was it decommissioned? *Date*
4.1d If not, when was it decommissioned? *Date*
4.1e Was this an energy, waste, or productivity measure (choose one)? ***E W P***

4.1f What would you estimate the annual cost savings of this measure to be?
($/ year;, suggest original estimate of $______/yr for client reference)

4.1g (Energy Only) Please indicate the source of energy conserved from the following:
Electricity Natural Gas Fuel Oil Coal Other

4.1h What would you estimate the annual energy savings of this measure to be?
(may be the same as the original estimate, suggest original estimate for client reference)

Q5. Sometimes, as a result of contact with the IAC Program, clients are inspired to develop their own energy conservation measures that are different from those provided in the IAC report. I will read you a list of activities that sometimes result from client interaction with the IAC. Please identify the activities that have taken place at your facility, as a result of your contact with the IAC.

5.1 Established an in-house conservation program . . . . *Y N*
5.2 Designated an existing employee as in-house energy manager . . . . *Y N*
5.3 Hired an energy manager or energy engineer . . . . *Y N*
5.4 Worked with an Energy Services Company . . . . *Y N*

5.5 Worked more closely with local utilities to identify opportunities to save energy and/or money . . . . *Y N*
5.6 Encouraged energy-conscious specifications in selection of new equipment . . . . *Y N*
5.7 Encouraged energy-conscious specifications in design or redesign of processes . . . . . *Y N*
5.8 Encouraged energy-conscious operations of plant equipment . . . . *Y N*
5.9 Trained existing employees in energy management/energy awareness . . . . *Y N*
5.10 Continued your relationship with the IAC . . . . *Y N*
5.11 Took advantage of other conservation programs through state or local governments . *Y N*
5.12 Other *(list)*
5.13 None . . . . *Y N*

Q6. I'd like your impression of the energy conservation services provided by the IAC. For each aspect that I list, please tell me if the service was excellent, good, adequate, poor, very poor, or not applicable.
(Ratings: 1-Excellent, 2-Good, 3-Adequate, 4-Poor, 5-Very Poor, 6-Not Applicable)

6.1 Thoroughness of IAC energy conservation assessment *1 2 3 4 5 6*
6.2 Accuracy of recommendations *1 2 3 4 5 6*
6.3 Presentation of recommendations *1 2 3 4 5 6*
6.4 Appropriateness of recommendations *1 2 3 4 5 6*
6.5 Supporting technical details for recommendations *1 2 3 4 5 6*
6.6 Supporting financial details for recommendations *1 2 3 4 5 6*
6.7 Knowledge of energy conservation opportunities by IAC Team *1 2 3 4 5 6*
6.8 Time spent on-site for IAC team to address energy conservation issues *1 2 3 4 5 6*
6.9 IAC team/report compelled the appropriate decision makers to support implementation of energy conservation recommendations *1 2 3 4 5 6*
6.10 Availability of IAC for post-assessment questions and assistance *1 2 3 4 5 6*
6.11 Duration of IAC follow-up period for energy conservation recommendations (9-12 months following the report) *1 2 3 4 5 6*

Q7. I'd like your impression of the waste minimization services provided by the IAC. For each aspect that I list, please tell me if the service was excellent, good, adequate, poor, very poor, or not applicable. (Assessments after 1994 only) (Ratings: 1-Excellent, 2-Good, 3-Adequate, 4-Poor, 5-Very Poor, 7-Not Applicable)

7.1 Thoroughness of IAC waste minimization assessment *1 2 3 4 5 6*
7.2 Accuracy of recommendations *1 2 3 4 5 6*
7.3 Presentation of recommendations *1 2 3 4 5 6*
7.4 Appropriateness of recommendations *1 2 3 4 5 6*
7.5 Supporting technical details for recommendations *1 2 3 4 5 6*
7.6 Supporting financial details for recommendations *1 2 3 4 5 6*
7.7 Knowledge of waste minimization issues by IAC Team *1 2 3 4 5 6*
7.8 Time spent on-site for IAC team to address waste minimization issues *1 2 3 4 5 6*

7.9 IAC team/report compelled the appropriate decision makers to support implementation of waste minimization recommendations *1 2 3 4 5 6*
7.10 Availability of IAC for post-assessment questions and assistance *1 2 3 4 5 6*
7.11 Duration of IAC follow-up period for waste minimization recommendations (9-12 months following the report) *1 2 3 4 5 6*

Q8. I'd like your impression of the productivity services provided by the IAC. For each aspect that I list, please tell me if the service was excellent, good, adequate, poor, very poor, or not applicable. (Assessments after 1996 only) (Ratings: 1-Excellent, 2-Good, 3-Adequate, 4-Poor, 5-Very Poor, 6-Not Applicable)

8.1 Thoroughness of IAC productivity assessment *1 2 3 4 5 6*
8.2 Accuracy of recommendations *1 2 3 4 5 6*
8.3 Presentation of recommendations *1 2 3 4 5 6*
8.4 Appropriateness of recommendations *1 2 3 4 5 6*
8.5 Supporting technical details for recommendations *1 2 3 4 5 6*
8.6 Supporting financial details for recommendations *1 2 3 4 5 6*
8.7 Knowledge of productivity/production issues by IAC Team *1 2 3 4 5 6*
8.8 Time available on-site for IAC team to address productivity/production issues *1 2 3 4 5 6*
8.9 IAC team/report compelled the appropriate decision makers to support implementation of productivity recommendations *1 2 3 4 5 6*
8.10 Availability of IAC for post-assessment questions and assistance *1 2 3 4 5 6*
8.11 Duration of IAC follow-up period for productivity recommendations (9-12 months following the report) *1 2 3 4 5 6*

Now I'll ask you a series of questions about your company before and after its experience with the IAC.

Q9. Prior to your experience with the IAC, tell me how often your company identified opportunities to save energy in your plant.

1-Very Frequently, 2-Frequently, 3-Occasionally, 4-Rarely, 5-Never, 6- Don't Know

Q10. Following your experience with the IAC, tell me how often your company identifies opportunities available for saving energy in your plant.

1-Very Frequently, 2-Frequently, 3-Occasionally, 4-Rarely, 5-Never, 6- Don't Know

Q11. Prior to your experience with the IAC, tell me how often you company actually implemented measures that were intended to save energy in your plant?

1-Very Frequently, 2-Frequently, 3-Occasionally, 4-Rarely, 5-Never, 6- Don't Know

Q12. Following your experience with the IAC, tell me how often your company actually implements measures that are intended to save energy in your plant?

1-Very Frequently, 2-Frequently, 3-Occasionally, 4-Rarely, 5-Never, 6- Don't Know

Q13. Regarding the *performance* of the measures that the company implemented prior to your IAC assessment, what fraction actually provided payback periods of under 2 years?

1) 0% 2) 1%-20% 3) 21% - 40 4) 41% - 60% 5) 61% - 80% 6) 81%-100% 7) Don't Know

Q14. Regarding the *performance* of the measures that the company implemented following your IAC experience (not including those identified in the audit), what fraction actually provided payback periods of under 2 years?

1) 0% 2) 1%-20% 3) 21% - 40% 4) 41% - 60% 5) 61% - 80% 6) 81%-100% 7) Don't Know

A.2 RESPONSES TO MISCELLANEOUS QUESTIONS (Questions 5, 6, 7, 8)

Table A.1 presents a breakdown of other client-identified activities influenced by their interaction with the IAC. These actions were taken in addition to the implementation of ARs provided by the centers. Examples of typical actions taken by clients include designating an existing employee as in-house energy manager, working with an Energy Services Company (ESCO) or with the local utility to identify savings opportunities, and encouraged energy-conscious practices in the design, selection, or operation of plant equipment. Forty clients (out of 42 total) responded to these questions.

Of the 13 options offered to the clients (including “no action taken” and “other”), six actions were taken by 40 to 85% of the clients interviewed. In particular, 40% of the clients reported designating an existing employee as in-house energy manager, while 40% trained existing employees in energy management and energy awareness. Fifty-seven percent of those interviewed noted that they now encourage energy-conscious specifications in the design or redesign of their processes. Similarly, 80% encourage energy-conscious specifications in new equipment selection, and 85% encourage energy-conscious operation of their plant equipment. Finally, 65% mentioned that they now work more closely with their local utility to identify energy and cost saving opportunities. Clearly, based on these comments, the impact of the IAC reaches well beyond the direct savings generated by implemented ARs, into the behaviors and practices of the client. These results are supported by the responses to the questions on client decision-making.

Tables A.2 through A.4 present the results of questions on client impressions of energy, waste, and productivity services provided by the IAC Program. Because the sampled clients participated in IAC assessments over a period of several years, not all clients received waste and/or productivity services. Therefore, although 38 responded to questions regarding energy services, only 13 responded to questions on waste services, and 2 responded to questions on productivity services.

On average, client impressions of the energy-related services were rated adequate/good to excellent (Table A.2). The most favorable reviews were provided on issues of thoroughness of the assessment, presentation of energy-related recommendations, supporting technical details, and knowledge of energy conservation opportunities. The IAC’s ability to compel appropriate decision makers to implement ARs, the availability of centers for post-assessment assistance, and the duration of the follow-up period, although rated favorably at an average of good/adequate, seemed to be rated the weakest amongst the list of energy-related services provided.

Client impressions of waste-related services are presented in Table A.3. Presentation of waste recommendations, supporting technical details, and supporting financial details were rated most favorably (average ratings of excellent/good to good). Ratings provided on IAC’s ability to influence decision-makers, post-assessment availability, and the duration of follow-up period, although considered good/adequate on average, were again considered to be weakest among the waste-related services provided.

Because only two clients replied to the questions on productivity services, it may be premature to draw conclusions on the adequacy of services provided. Strengths (average rating of “good”) identified were presentation of productivity-related ARs, supporting technical details, and supporting financial details. Weaknesses (average ratings of “adequate/poor” to “poor/very poor”) again were identified in the areas of post-assessment availability and duration of follow-up period, in addition to the thoroughness of the productivity assessment.

Table A.1. Question 5: Other client-identified activities influenced by IAC interaction

Q#	Question	No	Yes	N/A	# of Responses
5.1	Established an in-house conservation program	27 (67.5%)	12 (30%)	1 (2.5%)	40
5.2	Designated an existing employee as in-house energy manager	23 (57.5%)	16 (40%)	1 (2.5%)	40
5.3	Hired an energy manager or energy engineer	38 (95%)	1 (2.5%)	1 (2.5%)	40
5.4	Worked with an Energy Services Company	28 (70%)	11 (27.5%)	1 (2.5%)	40
5.5	Worked more closely with local utilities to identify opportunities to save energy and/or money	13 (32.5%)	26 (65%)	1 (2.5%)	40
5.6	Encouraged energy-conscious specifications in selection of new equipment	7 (17.5%)	32 (80%)	1 (2.5%)	40
5.7	Encouraged energy-conscious specifications in design or redesign of processes	12 (30%)	23 (57.5%)	5 (12.5%)	40
5.8	Encouraged energy-conscious operations of plant equipment	5 (12.5%)	34 (85%)	1 (2.5%)	40
5.9	Trained existing employees in energy management/energy awareness	23 (57.5%)	16 (40%)	1 (2.5%)	40
5.10	Continued your relationship with the IAC	32 (80%)	7 (17.5%)	1 (2.5%)	40
5.11	Took advantage of other conservation programs through state or local governments	34 (85%)	5 (12.5%)	1 (2.5%)	40
5.12	Other (list)	0 (0%)	0 (0%)	0 (0%)	0
5.13	None	40 (100%)	0 (0%)	0 (0%)	40

Table A.2. Question 6: Client impression of energy-related services provided by the IAC
(Ratings: 1-Excellent, 2-Good, 3-Adequate, 4-Poor, 5-Very Poor, 6-Not Applicable)

Q#	Question	1=Excellent	2=Good	3=Adequate	4=Poor	5=Very Poor	6=Not Applicable	Average Rating
6.1	Thoroughness of IAC energy conservation assessment	17 (44.74%)	18 (47.37%)	3 (7.89%)	0 (0%)	0 (0%)	0 (0%)	1.6
6.2	Accuracy of recommendations	12 (31.58%)	20 (52.63%)	4 (10.53%)	0 (0%)	0 (0%)	2 (5.26%)	2.0
6.3	Presentation of recommendations	23 (60.53%)	15 (39.47%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1.4
6.4	Appropriateness of recommendations	9 (23.68%)	19 (50%)	8 (21.05%)	1 (2.63%)	0 (0%)	1 (2.63%)	2.1
6.5	Supporting technical details for recommendations	18 (47.37%)	14 (36.84%)	6 (15.79%)	0 (0%)	0 (0%)	0 (0%)	1.7
6.6	Supporting financial details for recommendations	14 (36.84%)	18 (47.37%)	4 (10.53%)	1 (2.63%)	0 (0%)	1 (2.63%)	1.9
6.7	Knowledge of energy conservation opportunities by IAC Team	20 (52.63%)	12 (31.58%)	4 (10.53%)	1 (2.63%)	0 (0%)	1 (2.63%)	1.7
6.8	Time spent on-site for IAC team to address energy conservation issues	15 (39.47%)	15 (39.47%)	4 (10.53%)	0 (0%)	0 (0%)	4 (10.53%)	2.1
6.9	IAC team/report compelled the appropriate decision makers to support implementation of energy conservation recommendations	6 (16.22%)	17 (45.95%)	8 (21.62%)	4 (10.81%)	0 (0%)	2 (5.41%)	2.5
6.10	Availability of IAC for post-assessment questions and assistance	11 (29.73%)	15 (40.54%)	3 (8.11%)	1 (2.7%)	0 (0%)	7 (18.92%)	2.6
6.11	Duration of IAC follow-up period for energy conservation recommendations (9–12 months following the report)	3 (8.11%)	26 (70.27%)	4 (10.81%)	1 (2.7%)	0 (0%)	3 (8.11%)	2.4

Table A.3. Question 7: Client impression of waste-related services provided by the IAC
(Ratings: 1-Excellent, 2-Good, 3-Adequate, 4-Poor, 5-Very Poor, 6-Not Applicable)

Q#	Question	1=Excellent	2=Good	3=Adequate	4=Poor	5=Very Poor	6=Not Applicable	Average Rating
7.1	Thoroughness of IAC waste minimization assessment	5 (38.5%)	3 (23.1%)	3 (23.1%)	2 (15.4%)	0 (0.0%)	0 (0.0%)	2.2
7.2	Accuracy of recommendations	2 (15.4%)	8 (61.5%)	1 (7.7%)	1 (7.7%)	0 (0.0%)	1 (7.7%)	2.4
7.3	Presentation of recommendations	7 (53.9%)	4 (30.8%)	2 (15.4%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1.6
7.4	Appropriateness of recommendations	3 (23.1%)	6 (46.2%)	2 (15.4%)	2 (15.4%)	0 (0.0%)	0 (0.0%)	2.2
7.5	Supporting technical details for recommendations	5 (38.5%)	4 (30.8%)	4 (30.8%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1.9
7.6	Supporting financial details for recommendations	5 (38.5%)	4 (30.8%)	4 (30.8%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1.9
7.7	Knowledge of waste minimization issues by IAC Team	6 (46.2%)	3 (23.1%)	2 (15.4%)	1 (7.7%)	1 (7.7%)	0 (0.0%)	2.1
7.8	Time spent on-site for IAC team to address waste minimization issues	7 (53.9%)	2 (15.4%)	3 (23.1%)	0 (0.0%)	0 (0.0%)	1 (7.7%)	2.0
7.9	IAC team/report compelled the appropriate decision makers to support implementation of waste minimization recommendations	2 (15.4%)	7 (53.9%)	2 (15.4%)	1 (7.7%)	0 (0.0%)	1 (7.7%)	2.5
7.10	Availability of IAC for post-assessment questions and assistance	4 (30.8%)	6 (46.2%)	0 (0.0%)	1 (7.7%)	0 (0.0%)	2 (15.4%)	2.5
7.11	Duration of IAC follow-up period for waste minimization recommendations (9–12 months following the report)	2 (14.3%)	6 (42.9%)	3 (21.4%)	0 (0.0%)	0 (0.0%)	2 (14.3%)	2.7

Table A.4. Question 8: Client impression of productivity services provided by the IAC
(Ratings: 1-Excellent, 2-Good, 3-Adequate, 4-Poor, 5-Very Poor, 6-Not Applicable)

Q#	Question	1=Excellent	2=Good	3=Adequate	4=Poor	5=Very Poor	6=Not Applicable	Average Rating
8.1	Thoroughness of IAC productivity assessment	0 (0.0%)	0 (0.0%)	1 (50.0%)	1 (50.0%)	0 (0.0%)	0 (0.0%)	3.5
8.2	Accuracy of recommendations	0 (0.0%)	1 (50.0%)	1 (50.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2.5
8.3	Presentation of recommendations	0 (0.0%)	2 (100.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2
8.4	Appropriateness of recommendations	0 (0.0%)	0 (0.0%)	1 (50.0%)	1 (50.0%)	0 (0.0%)	0 (0.0%)	3.5
8.5	Supporting technical details for recommendations	1 (50.0%)	0 (0.0%)	1 (50.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2
8.6	Supporting financial details for recommendations	1 (50.0%)	0 (0.0%)	1 (50.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2
8.7	Knowledge of productivity/production issues by IAC Team	0 (0.0%)	1 (50.0%)	0 (0.0%)	1 (50.0%)	0 (0.0%)	0 (0.0%)	3
8.8	Time spent on-site for IAC team to address productivity/production issues	0 (0.0%)	1 (50.0%)	1 (50.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	2.5
8.9	IAC team/report compelled the appropriate decision makers to support implementation of productivity recommendations	0 (0.0%)	1 (50.0%)	0 (0.0%)	1 (50.0%)	0 (0.0%)	0 (0.0%)	3
8.10	Availability of IAC for post-assessment questions and assistance	0 (0.0%)	1 (50.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (50.0%)	4
8.11	Duration of IAC follow-up period for productivity recommendations (9–12 months following the report)	0 (0.0%)	0 (0.0%)	1 (50.0%)	0 (0.0%)	0 (0.0%)	1 (50.0%)	4.5

A.3 CHARACTERISTICS OF PARTICIPATING CLIENTS

Candidates were selected at random from assessments performed during the period from 1992 through 1997. Figure A.1 categorizes the 42 clients who actually participated in the study by two-digit standard industry code (SIC). In general, the distribution seems to be spread across the range of SICs typically served by the IAC, with the exception of SICs 38 (Instruments) and 39 (Miscellaneous Manufacturing). More than 50% of the participating clients came from one of four SICs: 20 (Foods), 33 (Primary Metals), 34 (Fabricated Metals), and 35 (Industrial Machinery).

Figure A.2 presents the distribution of assessment dates for the clients that participated in the study. Fifty-eight percent of the participating clients received assessments during either 1994 or 1995. The earliest assessment occurred in 1992 and the latest two occurred in 1997.

The distribution of participating clients, by center, is provided in Fig. A.3. Twenty-one schools are represented by the sample of 42 clients that participated in the study. Forty-four percent of the clients came from four schools: Oklahoma, San Francisco, Wisconsin, and West Virginia.

Table A.5 lists the self-declared titles of the contacts from each participating plant. Twenty-nine percent identified themselves as a plant manager, while 24% identified themselves as some form of engineer.

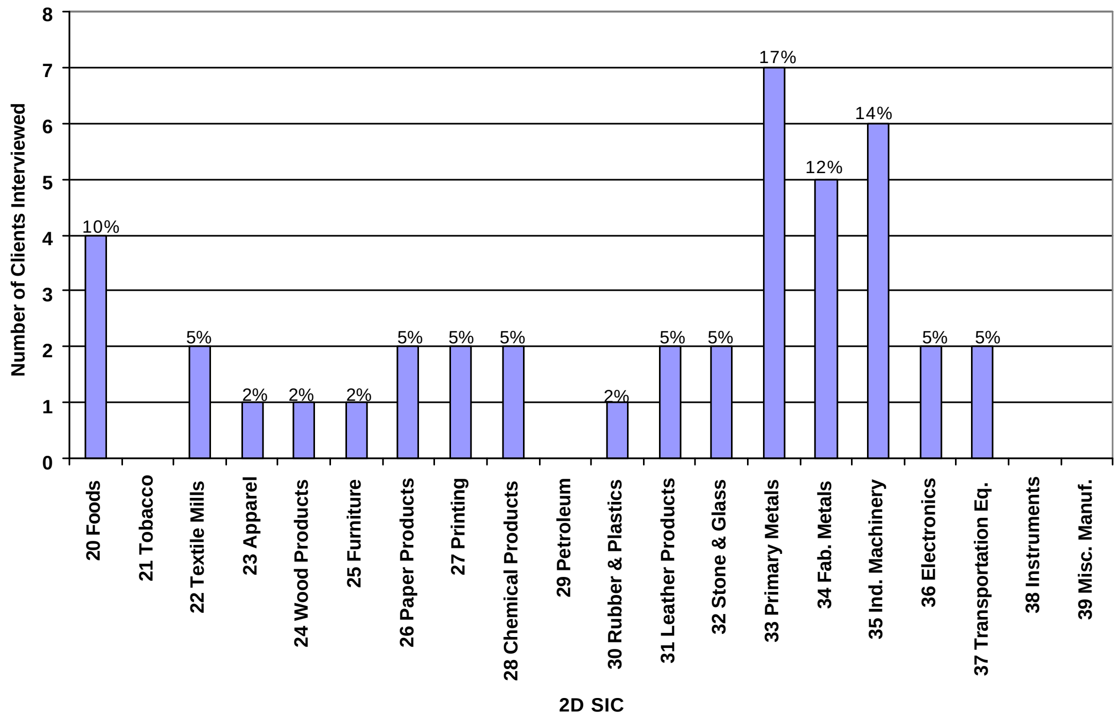

Fig. A.1. Distribution of two-digit standard industrial code for participating clients (42 total).

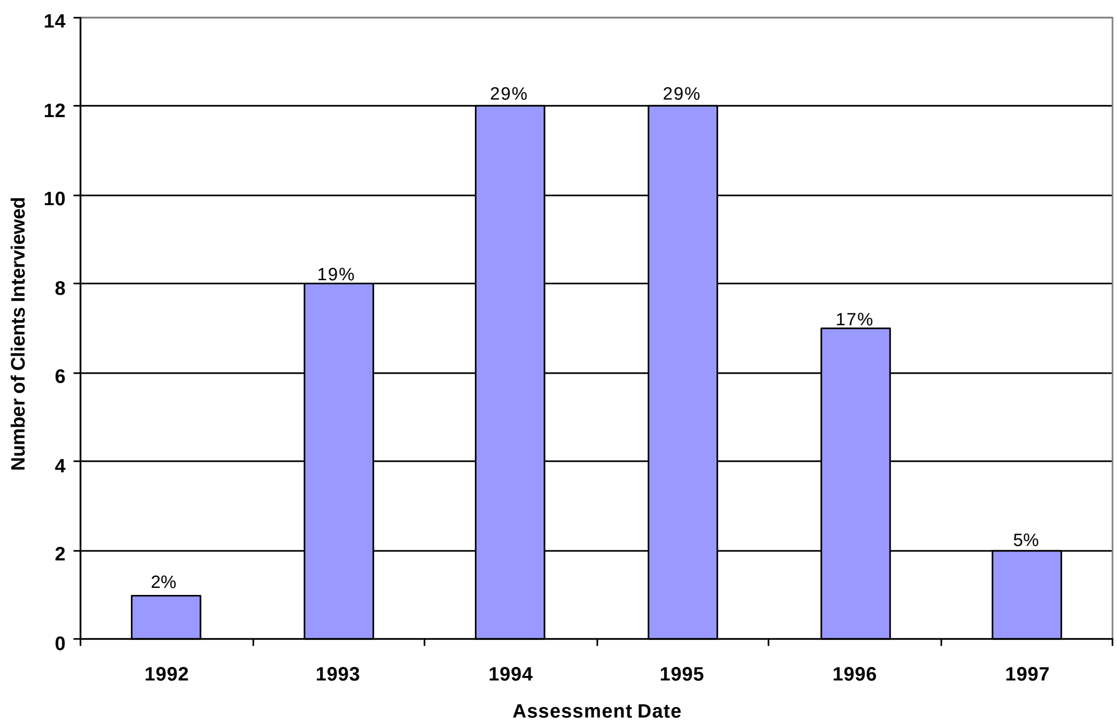

Fig. A.2. Distribution of assessment dates for 42 participating clients.

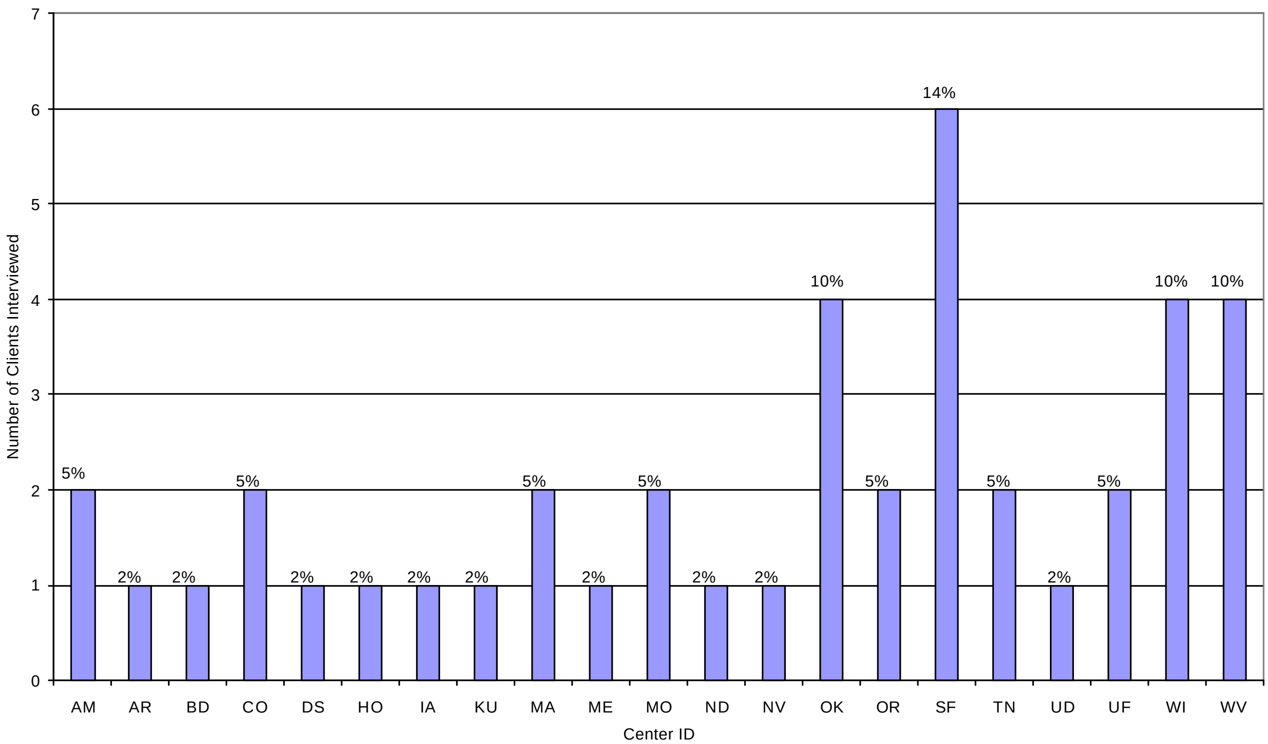

Fig. A.3 Distribution of assessment dates for 42 participating clients.

Table A.5. Titles of client contacts

Contact	Total	Percent of Sample
Administrator	2	5
Controller	2	5
Corporate Engineer	1	2
Director	1	2
Director of Engineer	1	2
Engineer	2	5
Engineering Manager	1	2
Facilities Manager	1	2
Foundry Supervisor	1	2
Maintenance Manager	1	2
Maintenance Personnel	1	2
Maintenance Supervisor	1	2
Manager	2	5
Mgr. Maintenance Eng	1	2
No Title	1	2
Operations Manager	1	2
Plant Engineer	3	7
Plant Manager	12	29
Plant Superintendent	1	2
President	1	2
Production Manager	1	2
Treasurer	1	2
Vice President	1	2
VP, Engineering	1	2
Work Manager	1	2
Grand Total	42	100

A.4 SUMMARY OF ASSESSMENT SAVINGS FOR PREVIOUSLY IMPLEMENTED, PREVIOUSLY UNIMPLEMENTED, INTERNALLY REPLICATED, EXTERNALLY REPLICATED, AND MISCELLANEOUS ASSESSMENT RECOMMENDATIONS

Table A.6 contains client-reported savings and original IAC savings estimates summarized to the assessment level. These are broken down by cost and site energy savings, and by benefit type: All (Comprehensive), Previously Implemented (Baseline), Previously Unimplemented, Internal Replication, External Replication, and Miscellaneous. These benefit types and Table A.6 are discussed in Sect. 3.3.

Table A.6. Savings by assessment and benefit type—with previously implemented totals

Client reference number	Fiscal year	Client response (site)	Client response (source)	Cost savings ($)	Energy site savings (MMBtu)	Energy source savings (MMBtu)
Unit: $, Benefit Type: All (Comprehensive)						
1	97	50,794.25		48,817.00	114.00	313.88
3	96	11,378.60		19,940.00	154.00	464.93
4	96	12,802.00		12,802.00	3,886.00	3,946.57
5	94	16,124.00		34,839.00	5,084.00	5,112.27
7	97	6,468.00		7,853.00	960.00	994.32
8	94	31,013.10		1,462.00	56.00	169.06
10	94	4,498.75		7,164.00	1,084.00	3,272.60
12	95	12,781.50		29,046.00	202.00	3,313.28
15	94	16,553.50		23,814.00	1,397.00	4,217.54
19	95	6,448.30		2,430.00	94.00	283.79
20	95	10,627.25		17,777.00	947.00	2,858.99
24	96	260,123.82		195,168.00	14,908.00	45,007.25
26	92	1,991.00		36,853.00	1,961.00	9,213.25
31	96	217.00		3,354.00	82.00	247.56
32	96	44,604.60		23,365.00	1,438.00	2,360.68
33	94	3,286.98		23,468.00	1,509.00	4,555.67
34	93	6,718.00		6,030.00	199.00	600.78
35	93	880.64		4,530.00	322.00	972.12
39	94	39,079.00		27,750.00	1,334.00	6,898.36
40	97	0.00		0.00	0.00	0.00
41	93	1,793.20		918.00	44.00	132.84
43	93	29,266.64		18,863.00	1,200.00	2,437.65
47	93	26,715.00		25,168.00	1,272.00	3,840.17

Table A.6 (Cont.) Savings by assessment and benefit type—with previously implemented totals						
Client reference number	**Fiscal year**	**Client response (site)**	**Client response (source)**	**Cost savings ($)**	**Energy site savings (MMBtu)**	**Energy source savings (MMBtu)**
48	96	3,434.00		4,247.00	155.00	467.95
55	95	10,815.60		2,781.00	252.00	760.79
57	95	532,705.55		285,351.00	6,899.00	8,435.46
60	96	5,663.00		1,974.00	89.00	268.69
65	96	26,890.50		19,805.00	2,605.00	3,117.83
69	94	18,774.21		18,761.00	4,625.00	4,990.44
72	93	32,820.48		4,035.00	196.00	591.72
75	95	32,247.25		32,542.00	943.00	2,846.92
80	96	8,518.00		75,068.00	1,879.00	3,597.17
81	95	11,878.00		55,807.00	1,345.00	4,060.56
84	95	6,106.00		2,935.00	661.00	755.89
88	94	3,669.50		4,170.00	158.00	477.00
89	93	12,182.50		23,501.00	5,220.00	6,185.08
90	95	15,837.70		4,129.00	217.00	471.39
92	96	1,987.00		4,535.00	119.00	359.26
94	95	8,204.50		9,319.00	274.00	282.08
95	94	1,616.48		8,728.00	288.00	869.47
96	93	7,104.20		2,999.00	197.00	362.56
98	95	7,583.28		10,195.00	715.00	1,728.54
Unit: $, Benefit Type: Implemented (Baseline)						
1	97	47,766.25		48,817.00	114.00	313.88
3	96	5,003.00		19,940.00	154.00	464.93
4	96	12,802.00		12,802.00	3,886.00	3,946.57
5	94	16,124.00		34,839.00	5,084.00	5,112.27
7	97	6,468.00		7,853.00	960.00	994.32
8	94	2,253.92		1,462.00	56.00	169.06
10	94	109.50		7,164.00	1,084.00	3,272.60
12	95	10,781.50		29,046.00	202.00	3,313.28
15	94	16,553.50		23,814.00	1,397.00	4,217.54
19	95	2,430.00		2,430.00	94.00	283.79
20	95	9,179.25		17,777.00	947.00	2,858.99
24	96	255,670.08		195,168.00	14,908.00	45,007.25
26	92	1,991.00		36,853.00	1,961.00	9,213.25
31	96	217.00		3,354.00	82.00	247.56
32	96	25,197.60		23,365.00	1,438.00	2,360.68

Table A.6 (Cont.) Savings by assessment and benefit type—with previously implemented totals						
Client reference number	**Fiscal year**	**Client response (site)**	**Client response (source)**	**Cost savings ($)**	**Energy site savings (MMBtu)**	**Energy source savings (MMBtu)**
33	94	3,286.98		23,468.00	1,509.00	4,555.67
34	93	6,030.00		6,030.00	199.00	600.78
35	93	746.00		4,530.00	322.00	972.12
39	94	19,079.00		27,750.00	1,334.00	6,898.36
40	97	0.00		0.00	0.00	0.00
41	93	918.00		918.00	44.00	132.84
43	93	18,521.64		18,863.00	1,200.00	2,437.65
47	93	15,422.70		25,168.00	1,272.00	3,840.17
48	96	3,434.00		4,247.00	155.00	467.95
55	95	3,069.60		2,781.00	252.00	760.79
57	95	532,705.55		285,351.00	6,899.00	8,435.46
60	96	1,974.00		1,974.00	89.00	268.69
65	96	19,617.50		19,805.00	2,605.00	3,117.83
69	94	8,301.21		18,761.00	4,625.00	4,990.44
72	93	2,977.00		4,035.00	196.00	591.72
75	95	26,143.25		32,542.00	943.00	2,846.92
80	96	4,018.00		75,068.00	1,879.00	3,597.17
81	95	11,878.00		55,807.00	1,345.00	4,060.56
84	95	2,935.00		2,935.00	661.00	755.89
88	94	3,386.00		4,170.00	158.00	477.00
89	93	6,187.50		23,501.00	5,220.00	6,185.08
90	95	3,968.50		4,129.00	217.00	471.39
92	96	0.00		4,535.00	119.00	359.26
94	95	8,075.50		9,319.00	274.00	282.08
95	94	1,616.48		8,728.00	288.00	869.47
96	93	2,933.20		2,999.00	197.00	362.56
98	95	1,532.28		10,195.00	715.00	1,728.54
Unit: $, Benefit Type: Previously Unimplemented						
1	97	3,028.00		48,817.00	114.00	313.88
3	96	6,375.60		19,940.00	154.00	464.93
4	96	0.00		12,802.00	3,886.00	3,946.57
5	94	0.00		34,839.00	5,084.00	5,112.27
7	97	0.00		7,853.00	960.00	994.32
8	94	8,581.18		1,462.00	56.00	169.06
10	94	191.25		7,164.00	1,084.00	3,272.60

Table A.6 (Cont.) Savings by assessment and benefit type—with previously implemented totals						
Client reference number	**Fiscal year**	**Client response (site)**	**Client response (source)**	**Cost savings ($)**	**Energy site savings (MMBtu)**	**Energy source savings (MMBtu)**
12	95	0.00		29,046.00	202.00	3,313.28
15	94	0.00		23,814.00	1,397.00	4,217.54
19	95	4,018.30		2,430.00	94.00	283.79
20	95	1,448.00		17,777.00	947.00	2,858.99
24	96	2,716.74		195,168.00	14,908.00	45,007.25
26	92	0.00		36,853.00	1,961.00	9,213.25
31	96	0.00		3,354.00	82.00	247.56
32	96	19,407.00		23,365.00	1,438.00	2,360.68
33	94	0.00		23,468.00	1,509.00	4,555.67
34	93	0.00		6,030.00	199.00	600.78
35	93	134.64		4,530.00	322.00	972.12
39	94	0.00		27,750.00	1,334.00	6,898.36
40	97	0.00		0.00	0.00	0.00
41	93	875.20		918.00	44.00	132.84
43	93	10,745.00		18,863.00	1,200.00	2,437.65
47	93	5,550.30		25,168.00	1,272.00	3,840.17
48	96	0.00		4,247.00	155.00	467.95
55	95	0.00		2,781.00	252.00	760.79
57	95	0.00		285,351.00	6,899.00	8,435.46
60	96	1,749.00		1,974.00	89.00	268.69
65	96	0.00		19,805.00	2,605.00	3,117.83
69	94	10,473.00		18,761.00	4,625.00	4,990.44
72	93	29,843.48		4,035.00	196.00	591.72
75	95	3,282.00		32,542.00	943.00	2,846.92
80	96	0.00		75,068.00	1,879.00	3,597.17
81	95	0.00		55,807.00	1,345.00	4,060.56
84	95	2,921.00		2,935.00	661.00	755.89
88	94	283.50		4,170.00	158.00	477.00
89	93	395.00		23,501.00	5,220.00	6,185.08
90	95	1,546.20		4,129.00	217.00	471.39
92	96	1,987.00		4,535.00	119.00	359.26
94	95	0.00		9,319.00	274.00	282.08
95	94	0.00		8,728.00	288.00	869.47
96	93	4,171.00		2,999.00	197.00	362.56
98	95	0.00		10,195.00	715.00	1,728.54

Table A.6 (Cont.) Savings by assessment and benefit type—with previously implemented totals						
Client reference number	**Fiscal year**	**Client response (site)**	**Client response (source)**	**Cost savings ($)**	**Energy site savings (MMBtu)**	**Energy source savings (MMBtu)**
Unit: $, Benefit Type: Internal Replication						
1	97	0.00		48,817.00	114.00	313.88
3	96	0.00		19,940.00	154.00	464.93
4	96	0.00		12,802.00	3,886.00	3,946.57
5	94	0.00		34,839.00	5,084.00	5,112.27
7	97	0.00		7,853.00	960.00	994.32
8	94	0.00		1,462.00	56.00	169.06
10	94	110.00		7,164.00	1,084.00	3,272.60
12	95	2,000.00		29,046.00	202.00	3,313.28
15	94	0.00		23,814.00	1,397.00	4,217.54
19	95	0.00		2,430.00	94.00	283.79
20	95	0.00		17,777.00	947.00	2,858.99
24	96	0.00		195,168.00	14,908.00	45,007.25
26	92	0.00		36,853.00	1,961.00	9,213.25
31	96	0.00		3,354.00	82.00	247.56
32	96	0.00		23,365.00	1,438.00	2,360.68
33	94	0.00		23,468.00	1,509.00	4,555.67
34	93	688.00		6,030.00	199.00	600.78
35	93	0.00		4,530.00	322.00	972.12
39	94	20,000.00		27,750.00	1,334.00	6,898.36
40	97	0.00		0.00	0.00	0.00
41	93	0.00		918.00	44.00	132.84
43	93	0.00		18,863.00	1,200.00	2,437.65
47	93	5,742.00		25,168.00	1,272.00	3,840.17
48	96	0.00		4,247.00	155.00	467.95
55	95	0.00		2,781.00	252.00	760.79
57	95	0.00		285,351.00	6,899.00	8,435.46
60	96	0.00		1,974.00	89.00	268.69
65	96	0.00		19,805.00	2,605.00	3,117.83
69	94	0.00		18,761.00	4,625.00	4,990.44
72	93	0.00		4,035.00	196.00	591.72
75	95	0.00		32,542.00	943.00	2,846.92
80	96	0.00		75,068.00	1,879.00	3,597.17
81	95	0.00		55,807.00	1,345.00	4,060.56
84	95	0.00		2,935.00	661.00	755.89

Table A.6 (Cont.) Savings by assessment and benefit type—with previously implemented totals						
Client reference number	**Fiscal year**	**Client response (site)**	**Client response (source)**	**Cost savings ($)**	**Energy site savings (MMBtu)**	**Energy source savings (MMBtu)**
88	94	0.00		4,170.00	158.00	477.00
89	93	5,600.00		23,501.00	5,220.00	6,185.08
90	95	10,323.00		4,129.00	217.00	471.39
92	96	0.00		4,535.00	119.00	359.26
94	95	129.00		9,319.00	274.00	282.08
95	94	0.00		8,728.00	288.00	869.47
96	93	0.00		2,999.00	197.00	362.56
98	95	0.00		10,195.00	715.00	1,728.54
Unit: $, Benefit Type: External Replication						
1	97	0.00		48,817.00	114.00	313.88
3	96	0.00		19,940.00	154.00	464.93
4	96	0.00		12,802.00	3,886.00	3,946.57
5	94	0.00		34,839.00	5,084.00	5,112.27
7	97	0.00		7,853.00	960.00	994.32
8	94	900.00		1,462.00	56.00	169.06
10	94	110.00		7,164.00	1,084.00	3,272.60
12	95	0.00		29,046.00	202.00	3,313.28
15	94	0.00		23,814.00	1,397.00	4,217.54
19	95	0.00		2,430.00	94.00	283.79
20	95	0.00		17,777.00	947.00	2,858.99
24	96	1,737.00		195,168.00	14,908.00	45,007.25
26	92	0.00		36,853.00	1,961.00	9,213.25
31	96	0.00		3,354.00	82.00	247.56
32	96	0.00		23,365.00	1,438.00	2,360.68
33	94	0.00		23,468.00	1,509.00	4,555.67
34	93	0.00		6,030.00	199.00	600.78
35	93	0.00		4,530.00	322.00	972.12
39	94	0.00		27,750.00	1,334.00	6,898.36
40	97	0.00		0.00	0.00	0.00
41	93	0.00		918.00	44.00	132.84
43	93	0.00		18,863.00	1,200.00	2,437.65
47	93	0.00		25,168.00	1,272.00	3,840.17
48	96	0.00		4,247.00	155.00	467.95
55	95	7,746.00		2,781.00	252.00	760.79
57	95	0.00		285,351.00	6,899.00	8,435.46

Table A.6 (Cont.) Savings by assessment and benefit type—with previously implemented totals						
Client reference number	**Fiscal year**	**Client response (site)**	**Client response (source)**	**Cost savings ($)**	**Energy site savings (MMBtu)**	**Energy source savings (MMBtu)**
60	96	1,940.00		1,974.00	89.00	268.69
65	96	7,273.00		19,805.00	2,605.00	3,117.83
69	94	0.00		18,761.00	4,625.00	4,990.44
72	93	0.00		4,035.00	196.00	591.72
75	95	2,822.00		32,542.00	943.00	2,846.92
80	96	0.00		75,068.00	1,879.00	3,597.17
81	95	0.00		55,807.00	1,345.00	4,060.56
84	95	0.00		2,935.00	661.00	755.89
88	94	0.00		4,170.00	158.00	477.00
89	93	0.00		23,501.00	5,220.00	6,185.08
90	95	0.00		4,129.00	217.00	471.39
92	96	0.00		4,535.00	119.00	359.26
94	95	0.00		9,319.00	274.00	282.08
95	94	0.00		8,728.00	288.00	869.47
96	93	0.00		2,999.00	197.00	362.56
98	95	6,051.00		10,195.00	715.00	1,728.54
Unit: $, Benefit Type: Miscellaneous						
1	97	0.00		48,817.00	114.00	313.88
3	96	0.00		19,940.00	154.00	464.93
4	96	0.00		12,802.00	3,886.00	3,946.57
5	94	0.00		34,839.00	5,084.00	5,112.27
7	97	0.00		7,853.00	960.00	994.32
8	94	19,278.00		1,462.00	56.00	169.06
10	94	3,978.00		7,164.00	1,084.00	3,272.60
12	95	0.00		29,046.00	202.00	3,313.28
15	94	0.00		23,814.00	1,397.00	4,217.54
19	95	0.00		2,430.00	94.00	283.79
20	95	0.00		17,777.00	947.00	2,858.99
24	96	0.00		195,168.00	14,908.00	45,007.25
26	92	0.00		36,853.00	1,961.00	9,213.25
31	96	0.00		3,354.00	82.00	247.56
32	96	0.00		23,365.00	1,438.00	2,360.68
33	94	0.00		23,468.00	1,509.00	4,555.67
34	93	0.00		6,030.00	199.00	600.78
35	93	0.00		4,530.00	322.00	972.12

Table A.6 (Cont.) Savings by assessment and benefit type—with previously implemented totals						
Client reference number	**Fiscal year**	**Client response (site)**	**Client response (source)**	**Cost savings ($)**	**Energy site savings (MMBtu)**	**Energy source savings (MMBtu)**
39	94	0.00		27,750.00	1,334.00	6,898.36
40	97	0.00		0.00	0.00	0.00
41	93	0.00		918.00	44.00	132.84
43	93	0.00		18,863.00	1,200.00	2,437.65
47	93	0.00		25,168.00	1,272.00	3,840.17
48	96	0.00		4,247.00	155.00	467.95
55	95	0.00		2,781.00	252.00	760.79
57	95	0.00		285,351.00	6,899.00	8,435.46
60	96	0.00		1,974.00	89.00	268.69
65	96	0.00		19,805.00	2,605.00	3,117.83
69	94	0.00		18,761.00	4,625.00	4,990.44
72	93	0.00		4,035.00	196.00	591.72
75	95	0.00		32,542.00	943.00	2,846.92
80	96	4,500.00		75,068.00	1,879.00	3,597.17
81	95	0.00		55,807.00	1,345.00	4,060.56
84	95	250.00		2,935.00	661.00	755.89
88	94	0.00		4,170.00	158.00	477.00
89	93	0.00		23,501.00	5,220.00	6,185.08
90	95	0.00		4,129.00	217.00	471.39
92	96	0.00		4,535.00	119.00	359.26
94	95	0.00		9,319.00	274.00	282.08
95	94	0.00		8,728.00	288.00	869.47
96	93	0.00		2,999.00	197.00	362.56
98	95	0.00		10,195.00	715.00	1,728.54
Unit: MMBtu, Benefit Type: All (Comprehensive)						
1	97	291.00	404.06	48,817.00	114.00	313.88
3	96	154.00	464.93	19,940.00	154.00	464.93
4	96	3,886.00	3,946.57	12,802.00	3,886.00	3,946.57
5	94	5,070.00	5,070.00	34,839.00	5,084.00	5,112.27
7	97	916.00	916.00	7,853.00	960.00	994.32
8	94	4,147.93	8,508.83	1,462.00	56.00	169.06
10	94	51.25	83.55	7,164.00	1,084.00	3,272.60
12	95	475.25	1,926.91	29,046.00	202.00	3,313.28
15	94	955.50	2,884.65	23,814.00	1,397.00	4,217.54
19	95	247.90	748.41	2,430.00	94.00	283.79

Table A.6 (Cont.) Savings by assessment and benefit type—with previously implemented totals						
Client reference number	**Fiscal year**	**Client response (site)**	**Client response (source)**	**Cost savings ($)**	**Energy site savings (MMBtu)**	**Energy source savings (MMBtu)**
20	95	546.25	1,649.13	17,777.00	947.00	2,858.99
24	96	19,778.36	59,710.87	195,168.00	14,908.00	45,007.25
26	92	230.00	694.37	36,853.00	1,961.00	9,213.25
31	96	15.00	45.29	3,354.00	82.00	247.56
32	96	2,454.80	5,430.40	23,365.00	1,438.00	2,360.68
33	94	211.58	638.74	23,468.00	1,509.00	4,555.67
34	93	243.30	734.52	6,030.00	199.00	600.78
35	93	62.57	188.90	4,530.00	322.00	972.12
39	94	1,299.91	8,798.22	27,750.00	1,334.00	6,898.36
40	97	0.00	0.00	0.00	0.00	0.00
41	93	85.50	258.12	918.00	44.00	132.84
43	93	1,833.78	3,636.30	18,863.00	1,200.00	2,437.65
47	93	1,481.60	4,472.95	25,168.00	1,272.00	3,840.17
48	96	91.00	274.73	4,247.00	155.00	467.95
55	95	826.60	2,495.51	2,781.00	252.00	760.79
57	95	7,339.30	8,857.18	285,351.00	6,899.00	8,435.46
60	96	287.00	678.69	1,974.00	89.00	268.69
65	96	4,803.00	5,530.75	19,805.00	2,605.00	3,117.83
69	94	1,555.72	1,953.46	18,761.00	4,625.00	4,990.44
72	93	1,531.44	4,623.42	4,035.00	196.00	591.72
75	95	963.83	2,909.80	32,542.00	943.00	2,846.92
80	96	2,051.00	2,119.65	75,068.00	1,879.00	3,597.17
81	95	826.80	2,496.11	55,807.00	1,345.00	4,060.56
84	95	822.17	1,242.46	2,935.00	661.00	755.89
88	94	139.40	420.85	4,170.00	158.00	477.00
89	93	2,422.56	3,048.85	23,501.00	5,220.00	6,185.08
90	95	616.90	1,678.69	4,129.00	217.00	471.39
92	96	52.00	156.99	4,535.00	119.00	359.26
94	95	75.50	91.65	9,319.00	274.00	282.08
95	94	53.60	161.82	8,728.00	288.00	869.47
96	93	825.00	960.27	2,999.00	197.00	362.56
98	95	579.95	1,299.32	10,195.00	715.00	1,728.54
Unit: MMBtu, Benefit Type: Implemented (Baseline)						
1	97	64.00	162.93	48,817.00	114.00	313.88
3	96	154.00	464.93	19,940.00	154.00	464.93

Table A.6 (Cont.) Savings by assessment and benefit type—with previously implemented totals						
Client reference number	**Fiscal year**	**Client response (site)**	**Client response (source)**	**Cost savings ($)**	**Energy site savings (MMBtu)**	**Energy source savings (MMBtu)**
4	96	3,886.00	3,946.57	12,802.00	3,886.00	3,946.57
5	94	5,070.00	5,070.00	34,839.00	5,084.00	5,112.27
7	97	916.00	916.00	7,853.00	960.00	994.32
8	94	111.68	337.16	1,462.00	56.00	169.06
10	94	8.00	24.15	7,164.00	1,084.00	3,272.60
12	95	366.25	1,597.84	29,046.00	202.00	3,313.28
15	94	955.50	2,884.65	23,814.00	1,397.00	4,217.54
19	95	94.00	283.79	2,430.00	94.00	283.79
20	95	464.25	1,401.57	17,777.00	947.00	2,858.99
24	96	19,529.48	58,959.50	195,168.00	14,908.00	45,007.25
26	92	230.00	694.37	36,853.00	1,961.00	9,213.25
31	96	15.00	45.29	3,354.00	82.00	247.56
32	96	1,508.80	2,574.43	23,365.00	1,438.00	2,360.68
33	94	211.58	638.74	23,468.00	1,509.00	4,555.67
34	93	199.00	600.78	6,030.00	199.00	600.78
35	93	53.00	160.01	4,530.00	322.00	972.12
39	94	1,424.60	5,463.61	27,750.00	1,334.00	6,898.36
40	97	0.00	0.00	0.00	0.00	0.00
41	93	44.00	132.84	918.00	44.00	132.84
43	93	1,188.78	2,403.77	18,863.00	1,200.00	2,437.65
47	93	851.70	2,571.28	25,168.00	1,272.00	3,840.17
48	96	91.00	274.73	4,247.00	155.00	467.95
55	95	289.60	874.30	2,781.00	252.00	760.79
57	95	7,339.30	8,857.18	285,351.00	6,899.00	8,435.46
60	96	89.00	268.69	1,974.00	89.00	268.69
65	96	2,593.00	3,081.60	19,805.00	2,605.00	3,117.83
69	94	1,539.72	1,905.15	18,761.00	4,625.00	4,990.44
72	93	147.00	443.79	4,035.00	196.00	591.72
75	95	761.00	2,297.46	32,542.00	943.00	2,846.92
80	96	1,028.00	1,028.00	75,068.00	1,879.00	3,597.17
81	95	826.80	2,496.11	55,807.00	1,345.00	4,060.56
84	95	661.00	755.89	2,935.00	661.00	755.89
88	94	128.60	388.24	4,170.00	158.00	477.00
89	93	1,513.80	1,697.93	23,501.00	5,220.00	6,185.08
90	95	204.50	433.66	4,129.00	217.00	471.39

Table A.6 (Cont.) Savings by assessment and benefit type—with previously implemented totals						
Client reference number	**Fiscal year**	**Client response (site)**	**Client response (source)**	**Cost savings ($)**	**Energy site savings (MMBtu)**	**Energy source savings (MMBtu)**
92	96	0.00	0.00	4,535.00	119.00	359.26
94	95	71.50	79.58	9,319.00	274.00	282.08
95	94	53.60	161.82	8,728.00	288.00	869.47
96	93	193.00	350.48	2,999.00	197.00	362.56
98	95	242.95	281.92	10,195.00	715.00	1,728.54
Unit: MMBtu, Benefit Type: Previously Unimplemented						
1	97	227.00	241.13	48,817.00	114.00	313.88
3	96	0.00	0.00	19,940.00	154.00	464.93
4	96	0.00	0.00	12,802.00	3,886.00	3,946.57
5	94	0.00	0.00	34,839.00	5,084.00	5,112.27
7	97	0.00	0.00	7,853.00	960.00	994.32
8	94	47.25	142.65	1,462.00	56.00	169.06
10	94	35.25	35.25	7,164.00	1,084.00	3,272.60
12	95	0.00	0.00	29,046.00	202.00	3,313.28
15	94	0.00	0.00	23,814.00	1,397.00	4,217.54
19	95	153.90	464.62	2,430.00	94.00	283.79
20	95	82.00	247.56	17,777.00	947.00	2,858.99
24	96	4.88	14.73	195,168.00	14,908.00	45,007.25
26	92	0.00	0.00	36,853.00	1,961.00	9,213.25
31	96	0.00	0.00	3,354.00	82.00	247.56
32	96	946.00	2,855.97	23,365.00	1,438.00	2,360.68
33	94	0.00	0.00	23,468.00	1,509.00	4,555.67
34	93	0.00	0.00	6,030.00	199.00	600.78
35	93	9.57	28.89	4,530.00	322.00	972.12
39	94	0.00	0.00	27,750.00	1,334.00	6,898.36
40	97	0.00	0.00	0.00	0.00	0.00
41	93	41.50	125.29	918.00	44.00	132.84
43	93	645.00	1,232.53	18,863.00	1,200.00	2,437.65
47	93	292.10	881.85	25,168.00	1,272.00	3,840.17
48	96	0.00	0.00	4,247.00	155.00	467.95
55	95	0.00	0.00	2,781.00	252.00	760.79
57	95	0.00	0.00	285,351.00	6,899.00	8,435.46
60	96	(26.00)	127.44	1,974.00	89.00	268.69
65	96	0.00	0.00	19,805.00	2,605.00	3,117.83
69	94	16.00	48.30	18,761.00	4,625.00	4,990.44

Table A.6 (Cont.) Savings by assessment and benefit type—with previously implemented totals						
Client reference number	**Fiscal year**	**Client response (site)**	**Client response (source)**	**Cost savings ($)**	**Energy site savings (MMBtu)**	**Energy source savings (MMBtu)**
72	93	1,384.44	4,179.62	4,035.00	196.00	591.72
75	95	119.00	359.26	32,542.00	943.00	2,846.92
80	96	0.00	0.00	75,068.00	1,879.00	3,597.17
81	95	0.00	0.00	55,807.00	1,345.00	4,060.56
84	95	141.05	425.83	2,935.00	661.00	755.89
88	94	10.80	32.61	4,170.00	158.00	477.00
89	93	8.50	25.66	23,501.00	5,220.00	6,185.08
90	95	101.70	307.03	4,129.00	217.00	471.39
92	96	52.00	156.99	4,535.00	119.00	359.26
94	95	0.00	0.00	9,319.00	274.00	282.08
95	94	0.00	0.00	8,728.00	288.00	869.47
96	93	632.00	609.79	2,999.00	197.00	362.56
98	95	0.00	0.00	10,195.00	715.00	1,728.54
Unit: MMBtu, Benefit Type: Internal Replication						
1	97	0.00	0.00	48,817.00	114.00	313.88
3	96	0.00	0.00	19,940.00	154.00	464.93
4	96	0.00	0.00	12,802.00	3,886.00	3,946.57
5	94	0.00	0.00	34,839.00	5,084.00	5,112.27
7	97	0.00	0.00	7,853.00	960.00	994.32
8	94	0.00	0.00	1,462.00	56.00	169.06
10	94	4.00	12.08	7,164.00	1,084.00	3,272.60
12	95	109.00	329.07	29,046.00	202.00	3,313.28
15	94	0.00	0.00	23,814.00	1,397.00	4,217.54
19	95	0.00	0.00	2,430.00	94.00	283.79
20	95	0.00	0.00	17,777.00	947.00	2,858.99
24	96	0.00	0.00	195,168.00	14,908.00	45,007.25
26	92	0.00	0.00	36,853.00	1,961.00	9,213.25
31	96	0.00	0.00	3,354.00	82.00	247.56
32	96	0.00	0.00	23,365.00	1,438.00	2,360.68
33	94	0.00	0.00	23,468.00	1,509.00	4,555.67
34	93	44.30	133.74	6,030.00	199.00	600.78
35	93	0.00	0.00	4,530.00	322.00	972.12
39	94	(124.69)	3,334.61	27,750.00	1,334.00	6,898.36
40	97	0.00	0.00	0.00	0.00	0.00
41	93	0.00	0.00	918.00	44.00	132.84

Table A.6 (Cont.) Savings by assessment and benefit type—with previously implemented totals						
Client reference number	**Fiscal year**	**Client response (site)**	**Client response (source)**	**Cost savings ($)**	**Energy site savings (MMBtu)**	**Energy source savings (MMBtu)**
43	93	0.00	0.00	18,863.00	1,200.00	2,437.65
47	93	337.80	1,019.82	25,168.00	1,272.00	3,840.17
48	96	0.00	0.00	4,247.00	155.00	467.95
55	95	0.00	0.00	2,781.00	252.00	760.79
57	95	0.00	0.00	285,351.00	6,899.00	8,435.46
60	96	0.00	0.00	1,974.00	89.00	268.69
65	96	0.00	0.00	19,805.00	2,605.00	3,117.83
69	94	0.00	0.00	18,761.00	4,625.00	4,990.44
72	93	0.00	0.00	4,035.00	196.00	591.72
75	95	0.00	0.00	32,542.00	943.00	2,846.92
80	96	0.00	0.00	75,068.00	1,879.00	3,597.17
81	95	0.00	0.00	55,807.00	1,345.00	4,060.56
84	95	0.00	0.00	2,935.00	661.00	755.89
88	94	0.00	0.00	4,170.00	158.00	477.00
89	93	900.26	1,325.26	23,501.00	5,220.00	6,185.08
90	95	310.70	938.00	4,129.00	217.00	471.39
92	96	0.00	0.00	4,535.00	119.00	359.26
94	95	4.00	12.08	9,319.00	274.00	282.08
95	94	0.00	0.00	8,728.00	288.00	869.47
96	93	0.00	0.00	2,999.00	197.00	362.56
98	95	0.00	0.00	10,195.00	715.00	1,728.54
Unit: MMBtu, Benefit Type: External Replication						
1	97	0.00	0.00	48,817.00	114.00	313.88
3	96	0.00	0.00	19,940.00	154.00	464.93
4	96	0.00	0.00	12,802.00	3,886.00	3,946.57
5	94	0.00	0.00	34,839.00	5,084.00	5,112.27
7	97	0.00	0.00	7,853.00	960.00	994.32
8	94	0.00	0.00	1,462.00	56.00	169.06
10	94	4.00	12.08	7,164.00	1,084.00	3,272.60
12	95	0.00	0.00	29,046.00	202.00	3,313.28
15	94	0.00	0.00	23,814.00	1,397.00	4,217.54
19	95	0.00	0.00	2,430.00	94.00	283.79
20	95	0.00	0.00	17,777.00	947.00	2,858.99
24	96	244.00	736.64	195,168.00	14,908.00	45,007.25
26	92	0.00	0.00	36,853.00	1,961.00	9,213.25

Table A.6 (Cont.) Savings by assessment and benefit type—with previously implemented totals						
Client reference number	**Fiscal year**	**Client response (site)**	**Client response (source)**	**Cost savings ($)**	**Energy site savings (MMBtu)**	**Energy source savings (MMBtu)**
31	96	0.00	0.00	3,354.00	82.00	247.56
32	96	0.00	0.00	23,365.00	1,438.00	2,360.68
33	94	0.00	0.00	23,468.00	1,509.00	4,555.67
34	93	0.00	0.00	6,030.00	199.00	600.78
35	93	0.00	0.00	4,530.00	322.00	972.12
39	94	0.00	0.00	27,750.00	1,334.00	6,898.36
40	97	0.00	0.00	0.00	0.00	0.00
41	93	0.00	0.00	918.00	44.00	132.84
43	93	0.00	0.00	18,863.00	1,200.00	2,437.65
47	93	0.00	0.00	25,168.00	1,272.00	3,840.17
48	96	0.00		4,247.00	155.00	467.95
55	95	537.00	1,621.20	2,781.00	252.00	760.79
57	95	0.00	0.00	285,351.00	6,899.00	8,435.46
60	96	224.00	282.55	1,974.00	89.00	268.69
65	96	2,210.00	2,449.15	19,805.00	2,605.00	3,117.83
69	94	0.00	0.00	18,761.00	4,625.00	4,990.44
72	93	0.00	0.00	4,035.00	196.00	591.72
75	95	83.83	253.08	32,542.00	943.00	2,846.92
80	96	0.00	0.00	75,068.00	1,879.00	3,597.17
81	95	0.00	0.00	55,807.00	1,345.00	4,060.56
84	95	0.00	0.00	2,935.00	661.00	755.89
88	94	0.00	0.00	4,170.00	158.00	477.00
89	93	0.00	0.00	23,501.00	5,220.00	6,185.08
90	95	0.00	0.00	4,129.00	217.00	471.39
92	96	0.00	0.00	4,535.00	119.00	359.26
94	95	0.00	0.00	9,319.00	274.00	282.08
95	94	0.00	0.00	8,728.00	288.00	869.47
96	93	0.00	0.00	2,999.00	197.00	362.56
98	95	337.00	1,017.40	10,195.00	715.00	1,728.54
Unit: MMBtu, Benefit Type: Miscellaneous						
1	97	0.00	0.00	48,817.00	114.00	313.88
3	96	0.00	0.00	19,940.00	154.00	464.93
4	96	0.00	0.00	12,802.00	3,886.00	3,946.57
5	94	0.00	0.00	34,839.00	5,084.00	5,112.27
7	97	0.00	0.00	7,853.00	960.00	994.32

Table A.6 (Cont.) Savings by assessment and benefit type—with previously implemented totals						
Client reference number	**Fiscal year**	**Client response (site)**	**Client response (source)**	**Cost savings ($)**	**Energy site savings (MMBtu)**	**Energy source savings (MMBtu)**
8	94	3,989.00	8,029.02	1,462.00	56.00	169.06
10	94	0.00	0.00	7,164.00	1,084.00	3,272.60
12	95	0.00	0.00	29,046.00	202.00	3,313.28
15	94	0.00	0.00	23,814.00	1,397.00	4,217.54
19	95	0.00	0.00	2,430.00	94.00	283.79
20	95	0.00	0.00	17,777.00	947.00	2,858.99
24	96	0.00	0.00	195,168.00	14,908.00	45,007.25
26	92	0.00	0.00	36,853.00	1,961.00	9,213.25
31	96	0.00	0.00	3,354.00	82.00	247.56
32	96	0.00	0.00	23,365.00	1,438.00	2,360.68
33	94	0.00	0.00	23,468.00	1,509.00	4,555.67
34	93	0.00	0.00	6,030.00	199.00	600.78
35	93	0.00	0.00	4,530.00	322.00	972.12
39	94	0.00	0.00	27,750.00	1,334.00	6,898.36
40	97	0.00	0.00	0.00	0.00	0.00
41	93	0.00	0.00	918.00	44.00	132.84
43	93	0.00	0.00	18,863.00	1,200.00	2,437.65
47	93	0.00	0.00	25,168.00	1,272.00	3,840.17
48	96	0.00	0.00	4,247.00	155.00	467.95
55	95	0.00	0.00	2,781.00	252.00	760.79
57	95	0.00	0.00	285,351.00	6,899.00	8,435.46
60	96	0.00	0.00	1,974.00	89.00	268.69
65	96	0.00	0.00	19,805.00	2,605.00	3,117.83
69	94	0.00	0.00	18,761.00	4,625.00	4,990.44
72	93	0.00	0.00	4,035.00	196.00	591.72
75	95	0.00	0.00	32,542.00	943.00	2,846.92
80	96	1,023.00	1,091.65	75,068.00	1,879.00	3,597.17
81	95	0.00	0.00	55,807.00	1,345.00	4,060.56
84	95	20.12	60.73	2,935.00	661.00	755.89
88	94	0.00	0.00	4,170.00	158.00	477.00
89	93	0.00	0.00	23,501.00	5,220.00	6,185.08
90	95	0.00	0.00	4,129.00	217.00	471.39
92	96	0.00	0.00	4,535.00	119.00	359.26
94	95	0.00	0.00	9,319.00	274.00	282.08
95	94	0.00	0.00	8,728.00	288.00	869.47

Table A.6 (Cont.) Savings by assessment and benefit type—with previously implemented totals						
Client reference number	**Fiscal year**	**Client response (site)**	**Client response (source)**	**Cost savings ($)**	**Energy site savings (MMBtu)**	**Energy source savings (MMBtu)**
96	93	0.00	0.00	2,999.00	197.00	362.56
98	95	0.00	0.00	10,195.00	715.00	1,728.54

A.5 DATA PLOTS FOR STATISTICAL QUALITY ASSURANCE

Figures A.4–A.11 are plots comparing data from the client follow-up questionnaire with original IAC estimates for the primary purpose of checking the study results. Figures A.4–A.6 compare follow-up and original cost, and site and source energy savings estimates. Because many of the estimates are for previously unimplemented ARs, the IAC estimates refer to potential savings, not savings actually implemented. Because of the wide range in scales, results are presented as logs, and because savings estimates can be zero and (for energy) negative, each savings is first converted to its absolute values plus 1, before taking logs. Figures A.5–A.7 are analogous to Figures 4.6, but are at the assessment level rather than for particular ARs. Figures A.5–A.7 compare follow-up and original implemented total savings for assessments. Again results are on the log scale. Figures A.8 and A.9 compare follow-up and original implementation frequencies and rates for each assessment.

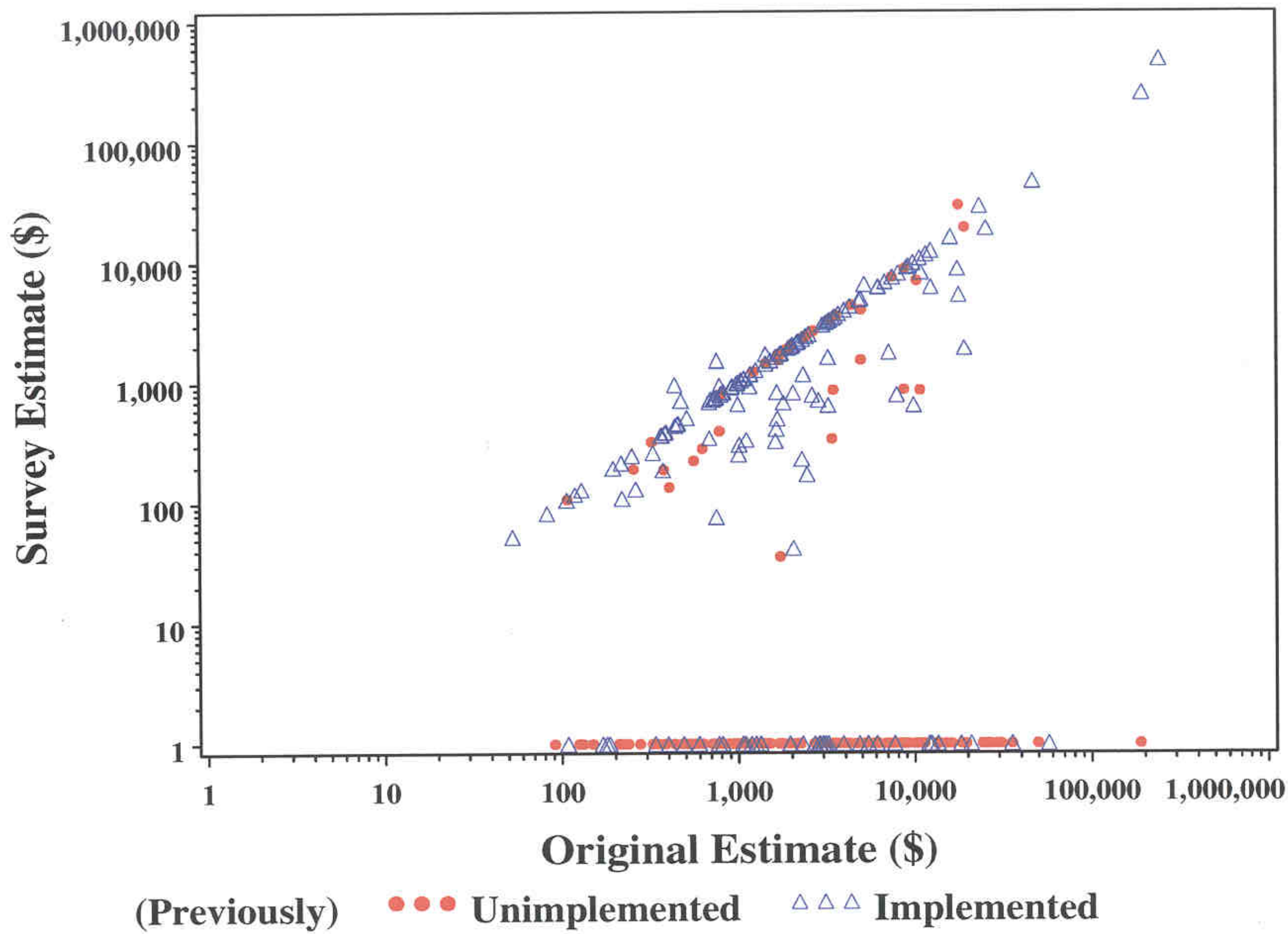

Fig. A.4. Follow-up vs original AR-Specific cost savings estimates (log of absolute value + 1).

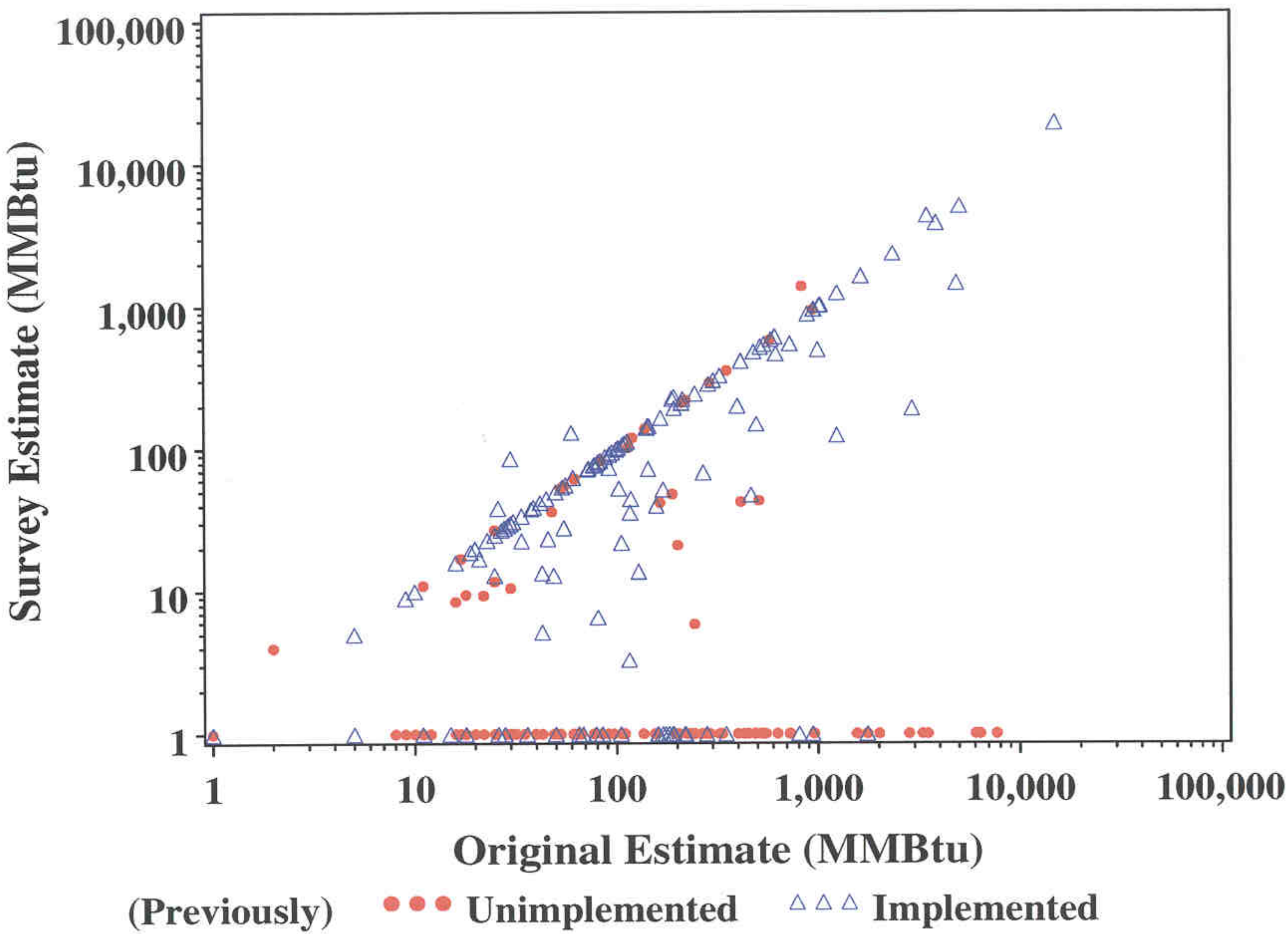

Fig. A.5. Follow-up vs original AR-specific site energy savings estimates (log of absolute value + 1).

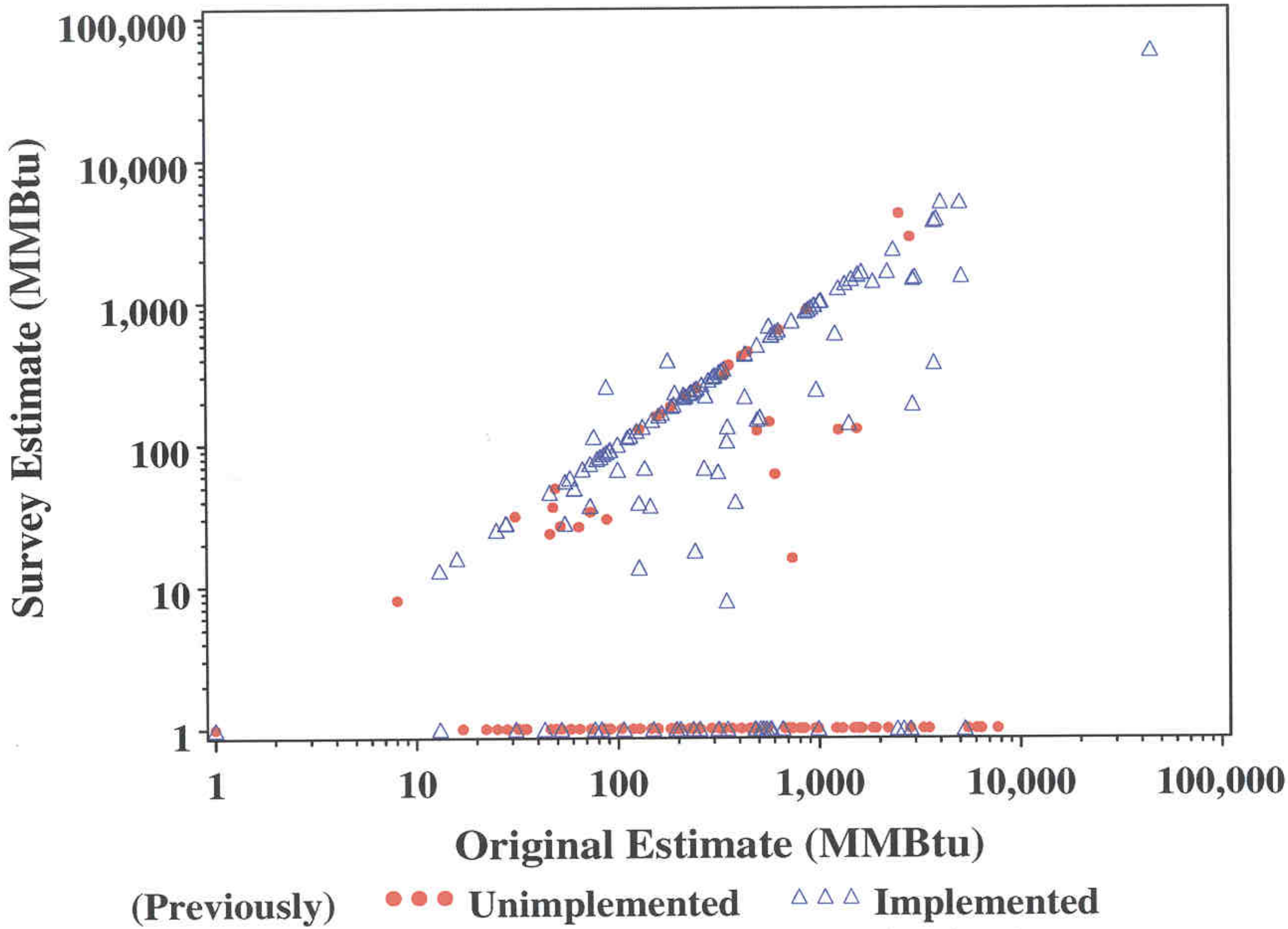

Fig. A.6. Follow-up vs original AR-specific source energy savings estimates (log of absolute value + 1).

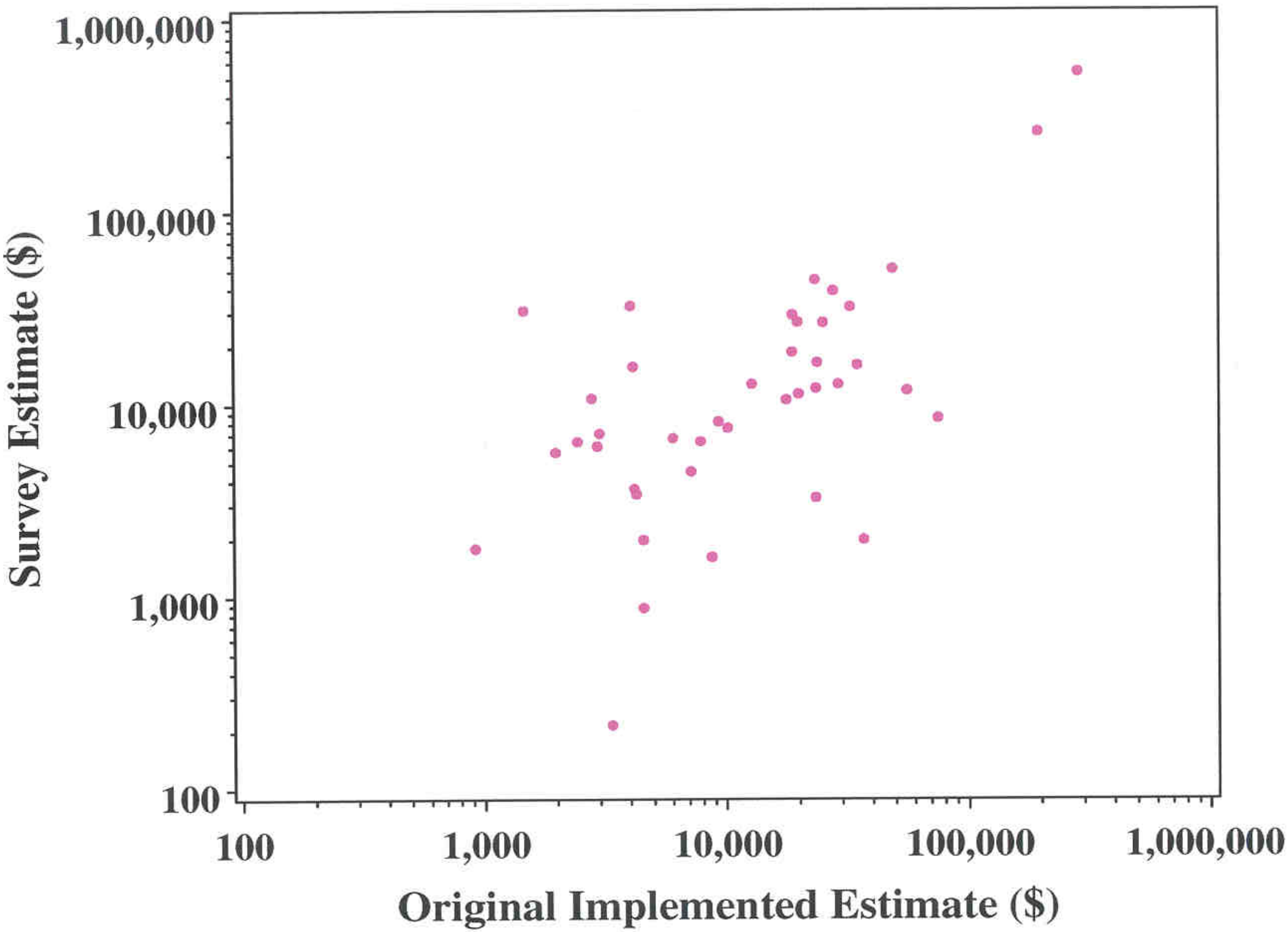

Fig. A.7. Follow-up vs original assessment total cost savings estimates (log scale).

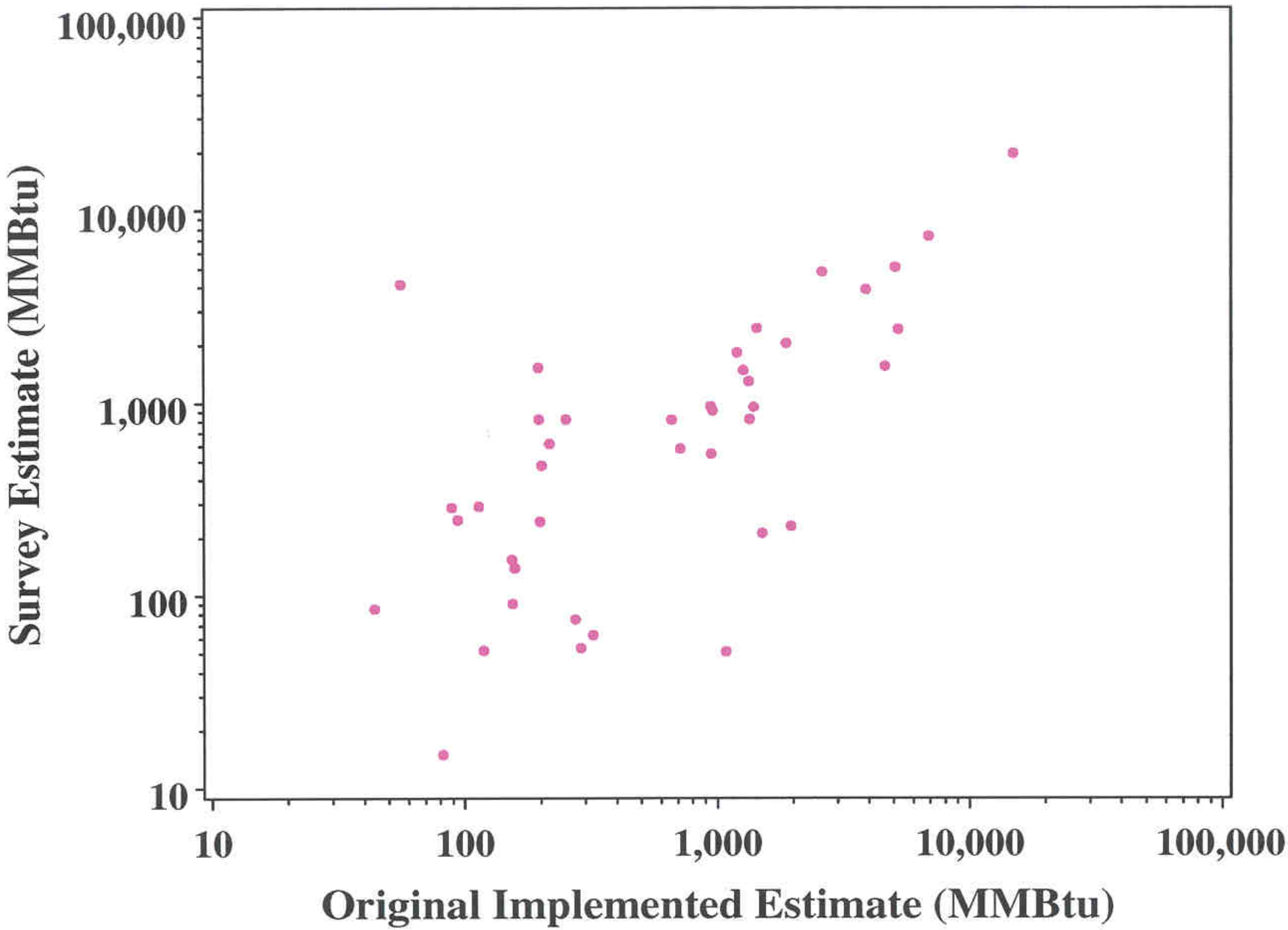

Fig. A.8. Follow-up vs original assessment total site energy savings estimates (log scale).

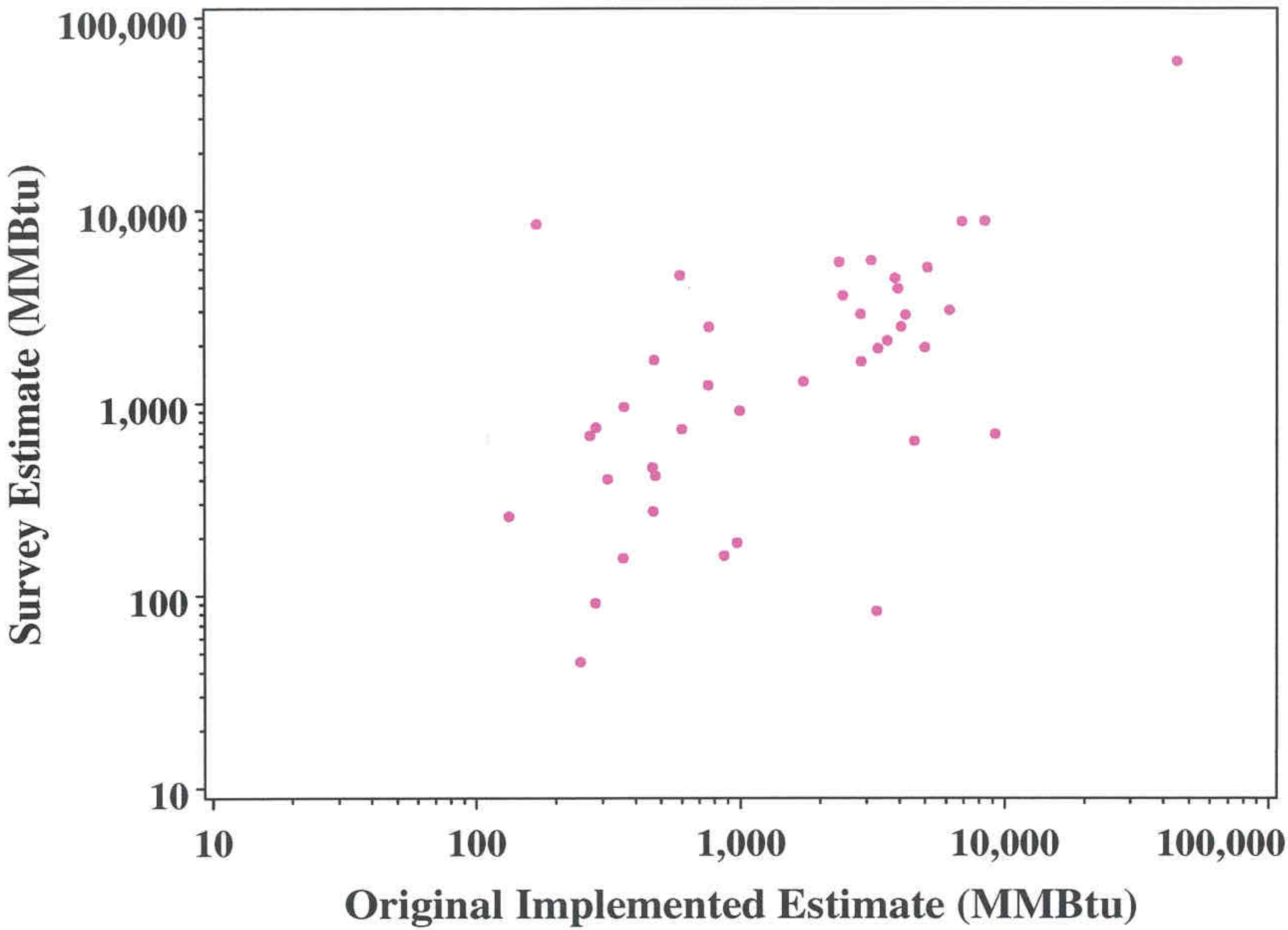

Fig. A.9. Follow-up vs original assessment total source energy savings estimates (log scale).

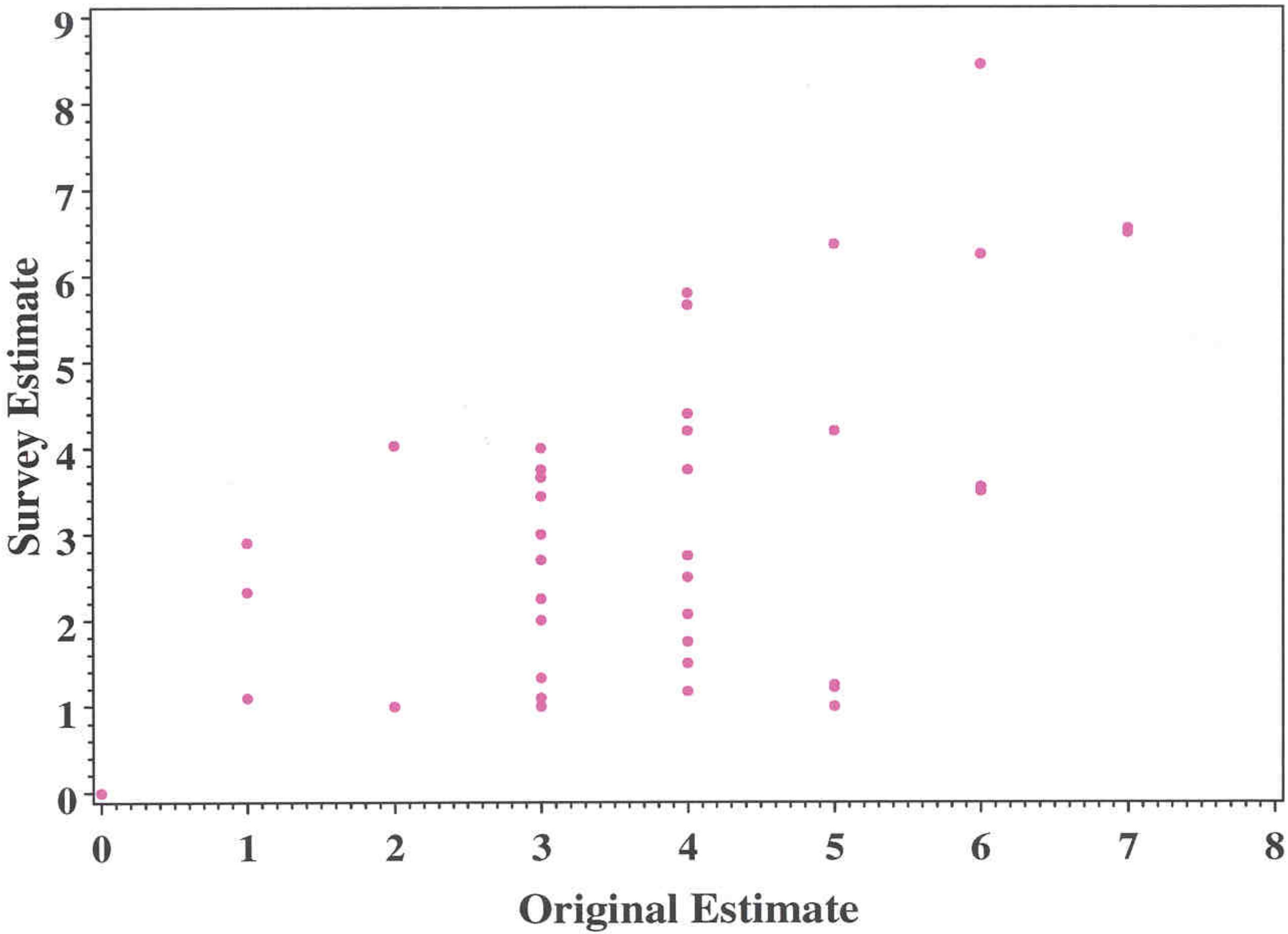

Fig. A.10. Follow-up vs original assessment implementation frequencies.

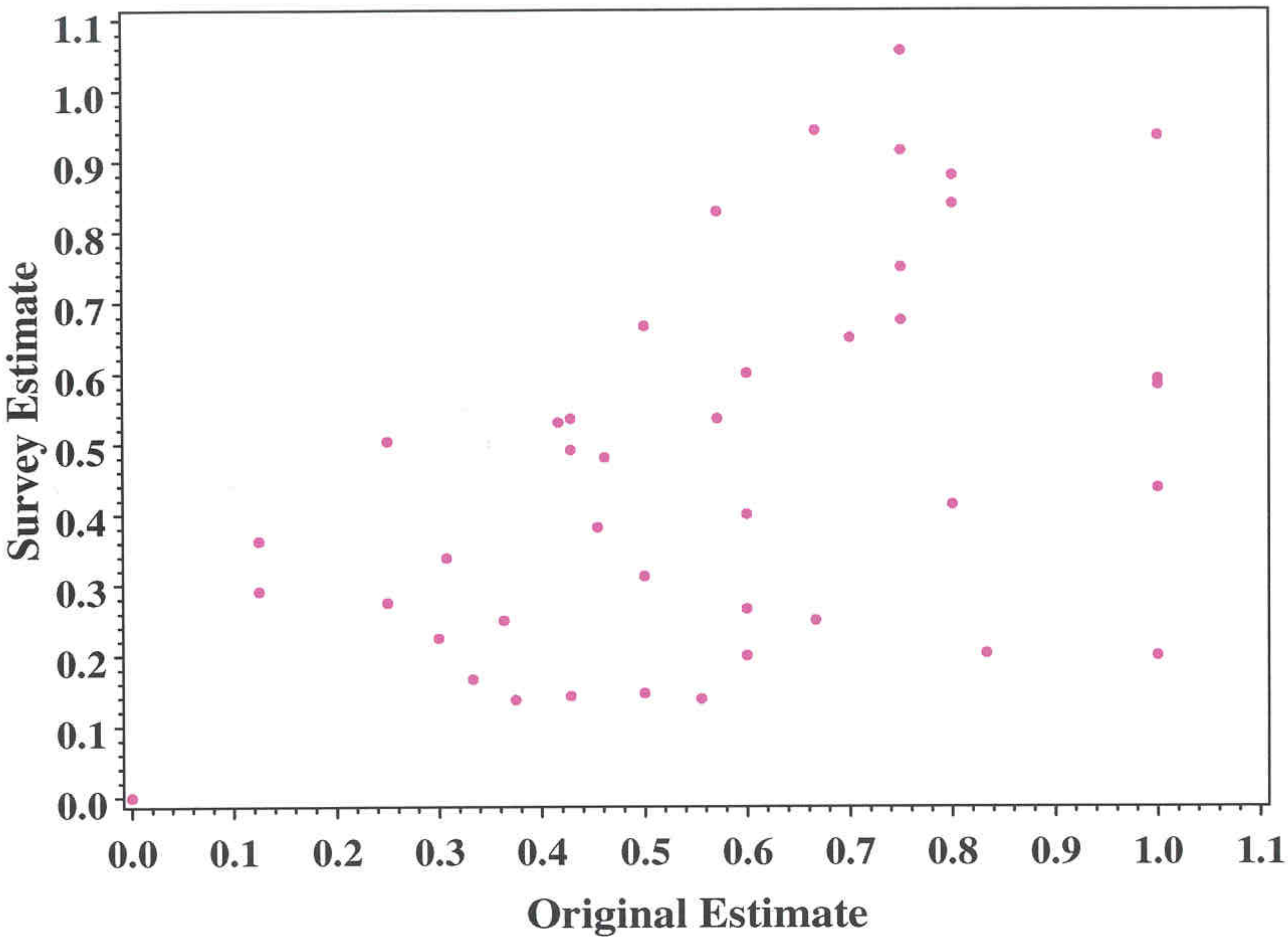

Fig. A.11. Follow-up vs original assessment implementation rates.

APPENDIX B. ALUMNI FOLLOW-UP QUESTIONNAIRE AND CHARACTERISTICS

CONTENTS

APPENDIX B.1 ALUMNI FOLLOW-UP QUESTIONNAIRE

Instructions: Please help with this year's important evaluation of the U.S. Department of Energy's Industrial Assessment Center (IAC) Program by completing this questionnaire. Your input is vital to help us understand the educational benefits and realized energy and cost savings of the IAC Program. The questionnaire should require 15 to 30 minutes to complete. Your answers will be kept strictly confidential. Please contact Bruce Tonn at Oak Ridge National Laboratory if you have any questions ([423] 574-4041, bet@ornl.gov). Please complete the questionnaire by March 15. You may return the questionnaire in the enclosed postage-paid envelope to Sheila Moore, Oak Ridge National Laboratory, PO Box 2008, Oak Ridge, TN, 37831-9004.

1. What year did you graduate from the school? ___________

2. What was your degree?____________________

3. What was your field of study?____________________

4. What school did you graduate from?_________________________

5. Upon entering the workforce, what was your starting annual base salary (*excluding* overtime pay, bonuses, and income from second jobs)? $________________(year)

6. Which of the following personal skills and capabilities were enhanced as a result of your participation in the IAC Program? (Check all that apply)
   [ ] Ability to grasp quickly the key features of new problems
   [ ] Breadth and depth of technical understanding
   [ ] Ability to define steps needed to solve new problems
   [ ] Ability to communicate ideas in writing
   [ ] Ability to communicate ideas verbally
   [ ] Creativity and innovativeness
   [ ] Integrating and synthesizing information from different fields
   [ ] Ability to work in teams
   [ ] Understanding the relationship between work and customer needs
   [ ] Meeting business goals while satisfying technical requirements
   [ ] Leadership ability
   [ ] Solving problems within the constraints of time, money, and human resources
   [ ] Ability to structure decisions and make good decisions
   [ ] Ability to transfer outside technology to the employer
   [ ] Confidence in ability to make appropriate recommendations
   [ ] None of the above

7. Please list any professional associations to which you belong.

   ____

____
____
____

8. What registrations and/or certifications have you received? (For example, are you a Professional Engineer or Architect?)
____
____
____
____

9. Please indicate in which of the following areas you are presently working. (Check all that apply)
[ ] energy savings
[ ] waste reduction
[ ] productivity enhancements
[ ] none of the above

10. a. Since participation in the IAC Program, have you held work-related positions where your job entailed findings ways to save energy, reduce waste, and/or enhance productivity in *industrial settings*?
[ ] Yes
[ ] No

b. If **Yes**, what energy-related activities involve (involved) the largest proportion of your energy-related work? (Check all that apply)
[ ] Exploration and extraction
[ ] Manufacturing
[ ] Electric power generation and transmission
[ ] Transportation and distribution
[ ] Conservation, utilization, management or storage of energy or fuel
[ ] End Use (lighting, HVAC, motors)
[ ] Other energy related activity, please specify ________________________________

Please answer the remaining questions with respect to your most recent position/job that entailed saving energy. (Note: If in your current (or last) position, you were acting as a consultant, please answer the questions for your average customer.)

11. What type of employer do (did) you work for? (Check one)
[ ] Manufacturing
[ ] Electric power/utility
[ ] Government (federal, state, local)
[ ] Consulting
[ ] Academia
[ ] Continued Study

[ ] Not an employee
[ ] Other, please specify ________________________

12. What are (were) your job duties? (Check all that apply)
[ ] Management
[ ] Education/training
[ ] Project engineer
[ ] Product engineer
[ ] Product R&D
[ ] Productivity/process engineering
[ ] Technician
[ ] Analyst
[ ] Facilities management
[ ] Support
[ ] Other, please specify________________________

13. Please estimate how much energy and/or costs have been saved by your employer due to your efforts and contributions related to your IAC training. Please provide a range (low-high) of numbers. If you wish to only provide one number per year, place these numbers in the 'low' columns. For energy savings please indicate the type of fuel being saved and provide estimates of *energy saved* in Btus. A conversion table is provided for your convenience. You may use the attached worksheet (P.8) to help you answer this question.

Year	Fuel type	Energy Savings (low) [in BTUS]	Energy Savings (high) [in BTUS]	Cost Savings (low) [in $]	Cost Savings (high) [in $]
1998					
1997					
1996					
1995					

Conversion Factors:
1 kWh electricity = 3,412 BTU (site)
1 therm natural gas = 100,000 BTU
1 gal. fuel oil (average) = 138,095 BTU
1 barrel fuel oil (average) = 5,800,000 BTU
1 CF (cubic foot) natural gas = 1,030 BTU
1 CCF (hundred cubic foot) natural gas = 103,000 BTU
1 MCF (thousand cubic feet) natural gas = 1,030,000 BTU
1 ton coal = 21,143,000 BTU
1 lb coal = 10,571 BTU

14. Please estimate how much costs have been saved by your employer associated with waste reductions and productivity enhancements due to your efforts and contributions related to your IAC training. You can use the attached worksheet (P.8) to help you answer this question.

Year	Cost Savings (low) [in $]	Cost Savings (high) [in $]
1998		
1997		
1996		
1995		

Questions 15-20 pertain to energy savings decisions at your place of employment. An energy savings *decision* entails consideration of the benefits and costs of implementing an energy savings measure. The decision itself may or may not result in the implementation of a measure, depending on the analysis of the benefits and costs. This is OK as long as your employer considers a sufficient number of energy savings options every year and uses the best available information to weigh benefits and costs.

15. Below is a list of issues common to energy savings decision making. Please rate the occurrence of these issues at your place of employment *before* you arrived there.

	Never	Rarely	Sometimes	Frequently	Always	No Opinion
a. Lack of knowledge about energy savings opportunities	1	2	3	4	5	9
b. Lack of knowledge about cost of energy savings measures	1	2	3	4	5	9
c. Lack of knowledge about how to quantify energy savings benefits	1	2	3	4	5	9
d. Lack of knowledge about other benefits (e.g., environmental) of energy savings measures	1	2	3	4	5	9
e. Lack of knowledge about how to make energy savings decisions	1	2	3	4	5	9

16. Below is a list of issues common to energy savings decision making. Please rate the occurrence of these issues at your place of employment *since* you arrived there.

	Never	Rarely	Sometimes	Frequently	Always	No Opinion
a. Lack of knowledge about energy savings opportunities	1	2	3	4	5	9
b. Lack of knowledge about cost of energy savings measures	1	2	3	4	5	9
c. Lack of knowledge about how to quantify energy savings benefits	1	2	3	4	5	9
d. Lack of knowledge about other benefits (e.g., environmental) of energy savings measures	1	2	3	4	5	9
e. Lack of knowledge about how to make energy savings decisions	1	2	3	4	5	9

17. How much influence have you had in helping your employer overcome each of these problems?

	None	Minimal	Moderate	Strong	Sole	No Opinion
a. Lack of knowledge about energy savings opportunities	1	2	3	4	5	9
b. Lack of knowledge about cost of energy savings measures	1	2	3	4	5	9
c. Lack of knowledge about how to quantify energy savings benefits	1	2	3	4	5	9
d. Lack of knowledge about other benefits (e.g., environmental) of energy savings measures	1	2	3	4	5	9
e. Lack of knowledge about how to make energy savings decisions	1	2	3	4	5	9

18. Please estimate how often your employer identifies (identified) opportunities to save energy.

	Never	Rarely	Occasionally	Frequently	Very Frequently	Don't Know
a. Before you arrived	1	2	3	4	5	9
b. After you arrived	1	2	3	4	5	9

19. Please estimate how often your employer implements (implemented) energy savings measures.

	Never	Rarely	Occasionally	Frequently	Very Frequently	Don't Know
a. Before you arrived	1	2	3	4	5	9
b. After you arrived	1	2	3	4	5	9

20. Please estimate what fraction of energy savings measures implemented provide (provided) reasonable payback period (under 2 years).

	0%	1-20%	41-60%	21-40%	61-80%	81-100%	Don't Know
a. Before you arrived	1	2	3	4	5	6	9
b. After you arrived	1	2	3	4	5	6	9

21. What other measures or actions were taken at your employer as a result of your influence? (Check all that apply)

[ ] Established an in-house conservation program
[ ] Designated an existing employee as in-house energy manager
[ ] Hired an energy manager or energy engineer
[ ] Worked with an Energy Services Company
[ ] Worked more closely with local utilities to identify opportunities to save energy and money
[ ] Encouraged energy-conscious specifications in selection of new equipment
[ ] Encouraged energy-conscious specifications in design or redesign of processes
[ ] Encouraged energy-conscious operations of plant equipment
[ ] Trained employees in energy management/energy awareness
[ ] Continued relationship with IAC
[ ] Took advantage of other programs through state or local governments
[ ] Other, please specify_________________________________
[ ] None

If you need assistance in estimating the numbers the answers for Question 13, please use the following worksheet.

Year	Measure(s) Implemented	Fuel Type	Energy Savings (low) [in BTUS]	Energy Savings (high) [in BTUS]	Cost Savings (low) [in $]	Cost Savings (high) [in $]

Year	Measure(s) Implemented	Fuel Type	Energy Savings (low) [in BTUS]	Energy Savings (high) [in BTUS]	Cost Savings (low) [in $]	Cost Savings (high) [in $]

If you need assistance in estimating the numbers the answers for Question 14, please use the following worksheet.

Year	Measure/Action	Cost Savings (low)	Cost Savings (high)

APPENDIX B.2. CHARACTERISTICS OF ALUMNI RESPONDENTS

This appendix presents summary statistics about the IAC Program alumni respondents.

Table B.1 indicates that most of the respondents graduated between 1992 and 1997. The mean graduation date is 1994, with a standard deviation of 3.5 years. This distribution of graduation dates mirrors the increase in the number of IAC centers in the early 1990s. Also, it would make sense that more recent graduates would be somewhat over represented in the sample because the centers would more likely have more up-to-date information on more recently graduated alumni addresses. Table B.2 indicates that a preponderance of the respondents are graduates of the University of Florida and Colorado State, with the University of South Dakota, Iowa State University, University of Missouri, and University of Kansas also well represented.

Table B.1. Reported alumni graduation dates.

Year	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1982	1	0.8	1	0.8
1983	1	0.8	2	1.5
1984	0	0	2	1.5
1985	2	1.5	4	3.0
1986	5	3.8	9	6.8
1987	2	1.5	11	8.3
1988	2	1.5	13	9.8
1989	3	2.3	16	12.1
1990	3	2.3	19	14.4
1991	5	3.8	24	18.2
1992	11	8.3	35	26.5
1993	12	9.1	47	35.6
1994	19	14.4	66	50.0
1995	14	10.6	80	60.6
1996	21	15.9	101	76.5
1997	19	14.4	120	90.9
1998	8	6.1	128	97.0
1999	4	3.0	132	100.0

Table B.2. Number of alumni respondents by school.

School	Frequency	Percent
University of Arkansas	2	1.5
Arizona State	1	0.8
Bradley University	4	3.0
Colorado State	10	7.6
University of Florida	15	11.4
Georgia Tech	0	0
Iowa State	8	6.1
Notre Dame	3	2.3
University of Kansas	8	6.1
University of Louisville	7	5.3
University of Massachusetts	5	3.8
University of Maine	2	1.5
University of Michigan	1	0.8
University of Missouri	8	6.1
Mississippi State	3	2.3
North Carolina State	2	1.5
University of Nevada	3	2.3
Hofstra University	3	2.3
University of Dayton	3	2.3
Old Dominion	2	1.5
Oklahoma State	4	3.0
Oregon State	9	6.8
San Diego State	0	0
San Francisco State	0	0
South Dakota State	9	6.8
University of Tennessee	4	3.0
Texas A&M	5	3.8
West Virginia	2	1.5
University of Wisconsin	2	1.5
Rensellaer Polytechnic	1	0.8
Rutgers	4	3.0
University of California-SB	1	0.8

Table B.3 indicates that most of the student participants in the IAC Program ended up earning bachelor of science degrees, with most of the rest earning master of science degrees. Table B.4 indicates that the vast majority of alumni majored in mechanical engineering, distantly followed by industrial, chemical and electrical engineering. However, the breadth of majors from biomedical engineering to computer information systems, is quite impressive. Tables B.5 and B.6 indicate that many of the alumni have gone on to join professional associations and earn professional certifications. The professional associations with the largest number of responding alumni are American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), American Society of Mechanical Engineers (ASME), and Association of Energy Engineers (AEE). The largest number of professional certifications are Engineer in Training (EIT), Professional Engineer (PE), and Certified Energy Manager (CEM).

Table B.3. Reported alumni degrees.

Degree	Frequency	Percent	Cumulative Frequency	Cumulative Percent
BS	74	56.1	74	56.1
MS	52	39.4	126	95.5
Ph.D	6	4.5	132	100.0

Table B.4. Fields of study for alumni.

Field of study	Frequency	Percent	Cumulative frequency	Cumulative percent
Architectural Engineering	2	1.5	2	1.5
Biomedical Engineering	1	0.8	3	2.3
Chemical Engineering	9	6.8	12	9.1
Civil Engineering	4	3.0	16	12.1
Computer Information Systems	1	0.8	17	12.9
Electrical Engineering	7	5.3	24	18.2
Energy Conservation	1	0.8	25	18.9
Engineering	1	0.8	26	19.7
Engineering Management	1	0.8	27	20.5
Environmental Engineering	2	1.5	29	22.0
Industrial Engineering	16	12.1	45	34.1
Materials Engineering	1	0.8	46	34.8
Mechanical Engineering	85	64.4	131	99.2
Thermosciences	1	0.8	132	100.0

Table B.5 Membership in professional associations reported by respondent alumni.

Type	Frequency	Percent
ABA	1	0.8
ACE	1	0.8
ACS	1	0.8
AEE	20	15.2
AIAA	1	0.8
AICE	2	1.5
AICHE	1	0.8
AIPA	1	0.8
AISES	1	0.8
AMSE	2	1.5
APHA	1	0.8
APS	1	0.8
ASA	1	0.8
ASCE	2	1.5
ASEE	2	1.5
ASES	1	0.8
ASHRAE	36	37.0
ASME	26	19.5
ASPE	1	0.8
ASQ	1	0.8
ASQE	1	0.8
BOMA	1	0.8
CDSM	1	0.8
IARW	1	0.8
IEEE	1	0.8
IES	1	0.8
IIE	5	3.8
ISA	1	0.8
ISPE	1	0.8
ITE	1	0.8
NFRC	1	0.8
NPPR	1	0.8
NSPE	1	0.8
R8PPR	1	0.8

Table B.5. (Cont.) Membership in professional associations reported by respondent alumni

Type **Frequency** **Percent**

SAE	6	4.5
SAME	1	0.8
SME	2	1.5
SPE	2	1.5
SQE	1	0.8
TAPPI	1	0.8
WWG	1	0.8
NA	48	36.4

Table B.6. Professional certifications and registrations of responding alumni.

Type	Frequency	Percent
CASM	1	0.8
CEM	17	12.0
CIT	1	0.8
CMGT	1	0.8
CQE	1	0.8
EIT	41	30.8
IRCA	1	0.8
MCSE	1	0.8
NYBar	1	0.8
PE	26	19.5
NA	63	47.7

Table B.7 summarizes the benefits provided to alumni through their experiences with the IAC Program. Alumni were allowed to check as many categories of benefits as they thought they received. The leading benefits are ability to work in teams; ability to communicate ideas in writing; confidence in ability to make appropriate recommendations; and solving problems within the constraints of time, money, and human resources. Certainly, the abilities to write, solve problems, and work in teams are among the most valuable traits that employers look for in prospective employees. Almost all of the remaining benefits were checked by at least 50% of the alumni respondents. Only one alumus indicated receiving no benefits from the program.

Table B.7. Benefits provided to alumni by the IAC

Benefit	Frequency	Percent
Ability to quickly grasp the key features of new problems	59	44.7
Breadth and depth of technical understanding	82	62.1
Ability to define steps needed to solve new problems	63	47.7
Ability to communicate ideas in writing	103	78.0
Ability to communicate ideas verbally	67	50.8
Creativity and innovativeness	68	51.5
Integrating and synthesizing information from different fields	68	51.5
Ability to work in teams	109	82.6
Understanding the relationship between work and customer needs	88	66.7
Meeting business goals while satisfying technical requirements	69	52.3
Leadership ability	80	60.6
Solving problems within the constraints of time, money, and human resources	92	69.7
Ability to structure decisions and make good decisions	49	37.1
Ability to transfer outside technology to the employer	67	50.8
Confidence in ability to make appropriate recommendations	95	72.0
None of the above	1	0.8

The mean starting salary for the IAC alumni respondents is $35,000 (the standard deviation is $12,000). This figure covers more than a decade of initial employment dates. Table B.8 indicates that most of the respondents are currently working in the energy savings area (46%), followed by the productivity enhancements area (35%) and waste reduction area (25%). Many IAC alumni respondents indicate that they do not work in any of these three areas (39%). Table B.9 indicates, however, that at some point in time, almost 70% of the alumni respondents worked at a job that entailed finding ways to save energy, reduce waste, and/or enhance productivity in settings. Most frequently, alumni turned their attention to end use, conservation, and/or manufacturing problems.

Table B.8. Areas in respondent alumni are current working.

Work area	Frequency	Percent
Energy savings	61	46.2
Waste reduction	33	25.0
Productivity enhancements	46	34.8
None of the above	52	39.4

Table B.9. Energy-related activities of alumni respondents.

Enhancement	Frequency	Percent
Held positions entailing enhancement in industrial setting	89	67.4
Exploration and extraction	4	3.0
Manufacturing	49	37.1
Electric power generation and transmission	16	12.1
Transportation and distribution	6	4.5
Conservation, utilization, management or storage of energy or fuel	39	29.5
End use (lighting, HVAC, motors)	58	43.9

Table B.10 indicates that most of the alumni respondents are employed by manufacturers. Almost 20% report working for consultants (more than 25% if one considers energy service companies as a special type of consulting organization), a job which mirrors their experiences in the IAC Program. Almost 10% work in the power industry or government. Table B.11 indicates that almost one-half of the alumni respondents shoulder project engineering responsibilities, where their IAC Program training would be readily applicable. Many hold management positions. Overall, most of the positions listed in Table B.11 could provide alumni with opportunities to assess potential energy savings and waste reduction and productivity enhancement opportunities.

Table B.10 Current employers of alumni respondents.

Type of Employer	Frequency	Percent
Manufacturing	45	35.7
Electric power/utility	12	9.5
Government (federal, state, local)	12	9.5
Consulting	25	19.8
Academia	7	5.6
Continued study	3	2.4
Not an employee	1	0.8
Energy Service Company	7	5.6
Transportation	2	1.6
Oil/Gas Industry	2	1.6
Insurance Industry	1	0.8
Mechanical Contractor	1	0.8
Non-energy Related	7	5.6

Table B.11 Job titles/duties of alumni respondents.

Job	Frequency	Percent
Management	31	23.5
Education/training	24	18.2
Project engineer	65	49.2
Product engineer	16	12.1
Product R&D	11	8.3
Productivity/process engineering	18	13.6
Technician	5	3.8
Analyst	21	15.9
Facilities management	6	4.5
Support	13	9.8

APPENDIX C. WEBSITE USERS QUESTIONNAIRE, RESPONSES TO QUALITATIVE QUESTIONS

CONTENTS

APPENDIX C.1 WEB QUESTIONNAIRE

IAC Program Web Questionnaire: The Use of IAC Online Technical Information

Welcome!

We sincerely appreciate you taking the time to participate in this online questionnaire. Your time, information and opinions are valuable to us. It should take only about 5 minutes to complete depending on your answers. Your input will help us understand how you use the IAC online information and what we can do to better serve you. Response to this questionnaire is voluntary, and all responses will be held in complete confidentiality.

About the Prizes...

We are offering the first thirty (30) participants who complete the questionnaire a FREE ASHRAE Pocket Guide (A $24 value)! Below is a quick description of the Pocket Guide:

The ASHRAE Pocket Guide is a valuable guide for engineers and technicians and provides rules of thumb, tables, charts, equations, diagrams, and conversion factors for HVAC/utility topics such as: air-handling and psychometrics, water and steam, motor characteristics and electrical data, heating/cooling loads, fuels and combustion, owning and operating costs, controls, and system design.

The Pocket Guide will be sent to the address that you provide at the end of the questionnaire. Any forms received incomplete (excluding those that contain questions that you are specifically directed to skip due to your answers) or with answers that are considered to be questionable, will not count toward the thirty and the participants will not be eligible to receive the Guide. Additionally, people currently involved with the IAC Program are not eligible for prizes and should not complete the questionnaire.

If you have read and understand the criteria for participating, just click on the link below to go to the questionnaire!

The IAC Web Users' Questionnaire

(The above text was the hyperlink to the Web Questionnaire which was in a separate html document)

IAC WEBSITES USE & REALIZED/POTENTIAL EXTENDED SAVINGS

1. Which IAC Program website(s) did you visit? (Check all that apply.)

- Rutgers OIPEA website (Rutgers)
- Colorado State University's IAC website (CSU)
- Both

2. How did you come across/learn of the website?

- Internet search engine (e.g., Yahoo, Alta Vista, Excite, Hotbot)
- Link from another website
- Just browsing
- Word of mouth
- Other (Please specify)

3. What information were you looking for when you found/accessed the website? (Check all that apply.)

- Specific Rutgers Technical Papers
- Specific Rutgers Database Documents
- Specific Rutgers Training Manuals
- Specific Rutgers IAC Program Documents
- Specific CSU Case Studies
- General IAC Program information
- General energy efficiency information
- General energy usage statistics
- Other (Please specify)

•

4. Are you downloading this information as support material for any of the following purposes? (Check all that apply.)

- Immediate value on a specific project
- Delayed value on a specific project
- Decision making
- Planning/Designing
- Expanding energy-efficiency knowledge base

- Expanding waste minimization/pollution prevention knowledge base
- Expanding process efficiency/productivity knowledge base
- Not downloading as support material
- Other (Please specify)

5. Have any of the following actions evolved out of your use of information found on either the Rutgers or CSU website? (Check all that apply.)

- Energy saving actions
- Money saving actions
- Waste reducing actions
- Productivity enhancing actions
- Raised concerns for energy efficiency
- No action

[If you answered "No action," please skip to question 14.]

6. Please estimate how much annual energy savings have resulted/will result from your use of the information you obtained: ("MMBTU" equals one million BTU; use the conversion table below if necessary.)

- No savings OR 0 MMBTU/yr
- <100 MMBTU/yr
- 100 - 250 MMBTU/yr
- 250 - 500 MMBTU/yr
- 500 - 1,000 MMBTU/yr
- 1,000 - 2,500 MMBTU/yr
- 2,500 - 10,000 MMBTU/yr
- 10,000 - 1,000,000 MMBTU/yr
- >1,000,000 MMBTU/yr

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1 kWh electricity = 3,412 BTU	1 therm natural gas = 100,000 BTU
1 gal. fuel oil (avg.) = 138,095 BTU	1 CCF natural gas = 103,000 BTU
1 short ton coal = 21,143,000 BTU	1 cubic foot natural gas = 1,030 BTU

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7. What was the dominant fuel type from which this savings occurred?

- Electricity
- Natural gas
- Fuel oil
- Coal
- No dominant fuel type
- Other (Please specify)

8. Please estimate how much annual cost savings have resulted/will result from the information you obtained related to energy efficiency or use reduction:

- No savings OR $0/yr
- <$100/yr
- $100 - $500/yr
- $500 - $1,000/yr
- $1,000 - $5,000/yr
- $5,000 - $25,000/yr
- $25,000 - $100,000/yr
- $100,000 - $1,000,000/yr
- >$1,000,000/yr

9. Please estimate how much annual cost savings have resulted/will result from the information you obtained related to waste minimization or pollution prevention:

- No savings OR $0/yr
- <$100/yr
- $100 - $500/yr
- $500 - $1,000/yr
- $1,000 - $5,000/yr
- $5,000 - $25,000/yr
- $25,000 - $100,000/yr
- $100,000 - $1,000,000/yr
- >$1,000,000/yr

10. Please estimate how much annual cost savings have resulted/will result from the information you obtained related to increasing productivity:

- No savings OR $0/yr
- <$100/yr
- $100 - $500/yr

- $500 - $1,000/yr
- $1,000 - $5,000/yr
- $5,000 - $25,000/yr
- $25,000 - $100,000/yr
- $100,000 - $1,000,000/yr
- >$1,000,000/yr

11. Were any of the measures or ideas that you implemented replicated elsewhere, within your facility, company, or by other plants, and if so, can you estimate the annual energy savings?

- No savings OR 0 MMBTU/yr
- <100 MMBTU/yr
- 100 - 250 MMBTU/yr
- 250 - 500 MMBTU/yr
- 500 - 1,000 MMBTU/yr
- 1,000 - 2,500 MMBTU/yr
- 2,500 - 10,000 MMBTU/yr
- 10,000 - 1,000,000 MMBTU/yr
- >1,000,000 MMBTU/yr

12. Please estimate how much annual cost savings have resulted/will result from the replicated savings:

- No savings OR $0/yr
- <$100/yr
- $100 - $500/yr
- $500 - $1,000/yr
- $1,000 - $5,000/yr
- $5,000 - $25,000/yr
- $25,000 - $100,000/yr
- $100,000 - $1,000,000/yr
- >$1,000,000/yr

13. If your company has achieved energy or cost savings from the use of information found on the IAC websites, are you still realizing those savings? If not, how long did the savings last?

A) Energy Savings

- Yes
- No

S Length savings realized (please use units of years [e.g., 0.5, 3.2])

- No savings achieved

B) Cost Savings

- Yes
- No

S Length savings realized (please use units of years [e.g., 0.5, 3.2])

- No savings achieved

14. Of the document(s) you obtained, which one was most helpful?

[Open space for comments.]

15. Have you or did you plan on passing the information you obtained to others, and if so, how many?

- Didn't plan on it OR 0 people
- 1 person
- 2-5 people
- 6-10 people
- 10-20 people
- 20-50 people
- >50 people

16. Prior to your utilizing technical information from an IAC website, how often did your company identify opportunities to save energy?

- Never
- Rarely
- Occasionally
- Frequently

- Very frequently
- Don’t know

17. Following your utilization of technical information from an IAC website, how often does your company identify opportunities to save energy?

- Never
- Rarely
- Occasionally
- Frequently
- Very frequently
- Don’t know

18. Prior to your utilizing technical information from an IAC website, how often did your company actually implement measures to save energy?

- Never
- Rarely
- Occasionally
- Frequently
- Very frequently
- Don’t know

19. Following your utilization of technical information from an IAC website, how often does your company actually implement measures to save energy?

- Never
- Rarely
- Occasionally
- Frequently
- Very frequently
- Don’t know

20. Regarding the *performance* of the measures your company implemented prior to your utilizing technical information from an IAC website, what fraction provided reasonable payback periods (under 2 years)?

- 0%
- 1% - 20%
- 21% - 40%
- 41% - 60%
- 61% - 80%
- 81% - 100%
- Don't know

21. Regarding the *performance* of the measures your company implemented following your utilizing technical information from an IAC website, what fraction provided reasonable payback periods (under 2 years)?

- 0%
- 1% - 20%
- 21% - 40%
- 41% - 60%
- 61% - 80%
- 81% - 100%
- Don't know

SITE CONTENT/USABILITY

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22. How satisfied were you with the information you obtained from the Rutgers or CSU website?

- Extremely satisfied
- Satisfied
- Indifferent
- Dissatisfied
- Extremely dissatisfied

23. How easy would you say it was to access the information on the website?

- Very easy
- Easy
- Of average easiness/difficulty for the Web
- Difficult
- Very difficult

24. What format do you prefer for downloadable documents?

- Pdf (portable document format)
- Word, Excel & Access (Microsoft)
- Word Perfect, Quattro Pro & Paradox (Corel)
- No preference

25. What recommendations do you have for improving either the content or usability of the Rutgers or CSU websites?

[Open space for comments.]

USER INFORMATION

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26. What is your email address, name, address and phone number? (The purpose for asking these questions is so that we can get in-touch with you to learn more about how you may have used IAC Program technical data.)

Email:
Name:
Address:
City:
State: Zip code:
Phone number:

27. What is your current occupation?

- Engineer
- Consultant
- Manager
- Scientist/researcher
- Academic/student
- Other (Please specify)

28. Which of these groups best describes your affiliation/organization for which you were accessing the website?

- Large industrial
- Small industrial
- Large commercial

- Small commercial
- Residential/consumer/private citizen
- Federal government
- State/local government
- Non-profit organization
- Educator
- Student
- Other (Please specify)

Submit Answers Clear Form

APPENDIX C.2 QUALITATIVE RESULTS

The following are the questions and responses from the Web questionnaire that were not addressed in Sect. 5 all are qualitative in nature. Each question is stated followed by a brief discussion of the results and a tabular breakdown of the data. In most cases, "Total responses" and "Savings responses" are supplied and are, respectively, a breakdown of all the responses received (29 participants) and those responses reporting energy and/or cost savings (11 participants).

Question 1: Which IAC Program Web site(s) did you visit? (Check all that apply)

Of the three sites listed as choices, only the Rutgers and CSU sites offer online IAC technical information. The Department of Energy's (DOE) Office of Industrial Technologies' (OIT) IAC Web site has links to both sites as well as a direct link to the IAC database, and was included for that reason. For both the total and savings responses sets, the greatest percentage of respondents visited the OIT and Rutgers sites. The CSU site contains more specific examples of previously utilized recommendations, where the Rutgers site offers a wider variety of technical information, including the database. However, noting that the IAC database has received some notoriety in recent years, it is still interesting that the CSU site experienced as many as one-quarter as many visitors as the Rutgers site, for those reporting savings. Recent information obtained on the number of homepage accesses each Web site receives indicates that the Rutgers site typically gets over 100 times the number of hits that the CSU site receives (CSU 1999, Mitrovic 1999).

Table C.1. IAC Program Websites visited.

Answer Choices	Total Responses		Savings Responses	
	No.	%-out of 29[a]	No.	%-out of 11[a]
DOE's OIT IAC Website	19	65.5	8	72.7
Rutgers OIPEA Website	18	62.1	9	81.8
CSUs IAC Website	4	13.8	3	27.3

[a] Percentages do not add up to 100% because respondents' ability to choose more than one answer.

Question 2: How did you come across/learn of the Web site?

The total responses to question 2 indicate that visitors are finding the IAC technical information in a number of different ways, however, the primary two response categories were by linking directly from another IAC Website (24.1%) and by locating the site through the use of a search engine (24.1%). The term "search engine" was used loosely here to include directories such as Yahoo, and examples were supplied to the respondent for clarity.

The savings responses breakdown brings out an interesting point worth noting. "Word of mouth" was chosen by 3of the 12 respondents and became tied with the previously mentioned top two categories for how a respondent who reported savings learned of the site he or she visited. This would seem to indicate that, without more data on which to evaluate this information, discussions of any type about the IAC Program and its resources are proving worthwhile.

Table C.2. Finding the IAC Websites.

Answer choices	**Total Responses**		**Savings Responses**	
	No.	**%**	**No.**	**%**
Link from other IAC Web site	7	24.1	3	27.3
Internet search engine (e.g., Yahoo, Alta Vista, Excite, Hotbot)	7	24.1	3	27.3
Link from another Website	5	17.2	2	18.2
Just browsing	1	3.5	0	0
Word of mouth	4	13.4	3	27.3
Other (Please specify)[a]	5	17.2	0	0
Totals	*29*	*100*	*11*	*100*

[a] "Other" responses supplied to this question were the following: Brochure from a Pennsylvania conference on energy; AEE seminar with Dr. Wayne Turner; DOE-NICE program Website; ACEEE conference; Chuck Glaser, Office of Technology Access.

Question 3: ***What information were you looking for when you found/accessed the Web site? (Check all that apply.)***

Two inferences as to what site visitors are looking for can be made from review of the responses to this question:

- that site visitors as a whole are looking for a wide variety of information, and
- that, by far, the two fields of information of greatest interest are the IAC database and general energy efficiency information, combined accounting for just over 47% of all the responses received (32 of 68).

It should be noted that while the IAC database contains a plethora of general statistics about small- to medium-sized facilities, the database also contains quite a large quantity of information about what types of energy efficiency measures certain industries (by SIC codes) are implementing. Thus, it appears that site visitors are looking for general *and* specific energy efficiency information.

For those reporting savings the breakdown is similar, with the two fields of information of greatest interest still being the IAC Database and general energy efficiency information.

Table C.3. Type of information visitors were seeking.

Answer Choices	**Total Responses**		**Savings Responses**	
	No.	**%-out of 29**[a]	**No.**	**%-out of 11**[a]
The Industrial Assessment Database	18	62.1	7	63.6
Specific Rutgers Database documents	2	6.9	1	9.1
Specific Rutgers training manuals	4	13.8	3	27.3
Specific Rutgers technical papers	2	6.9	2	18.2
Specific Rutgers IAC Program documents	2	6.9	1	9.1
Specific CSU energy efficiency recommendations	5	17.2	3	27.3
Specific CSU pollution prevention recommendations	4	13.8	2	18.2
General IAC Program information	5	17.2	1	9.1
General energy efficiency information	14	48.3	5	45.5
General energy usage statistics	9	31	4	36.4
Not looking for anything specifically	1	3.5	0	0
Other (Please specify)[b]	2	6.9	0	0

[a] Percentages do not add up to 100% because of respondents' ability to choose more than one answer.

[b] "Other" responses supplied to this question were the following: Information on projects that received help and the types of help received, and support information for marketing plans.

Question 4: Are you downloading this information as support material for any of the following purposes? (Check all that apply.)

Although a significant number of respondents (37.9%) stated that they were using the information downloaded for its immediate value on a specific project, the greatest majority of all respondents indicated that they were using the information downloaded for planning and design work (48.3%) and simply to expand their energy efficiency knowledge base (69%). It is also noteworthy that 38% and 21% of site visitors, respectively, are looking for information that will expand their process efficiency/productivity and waste minimization/pollution prevention knowledge bases, signifying that between one- and two-fifths of the visitors are either concerned about or at least interested in minimizing waste and/or improving process efficiency as well as energy efficiency.

For the group that specified savings, the breakdown changed very little. As expected, the choice "immediate value on a specific project" became a larger portion of the response set.

Table C.4. Downloading information as support material.

Answer Choices	**Total Responses**		**Savings Responses**	
	No.	**%-out of 29[a]**	**No.**	**%-out of 11[a]**
Immediate value on a specific project	11	37.9	5	45.5
Delayed value on a specific project	6	20.7	1	9.1
Decision making	8	27.6	3	27.3
Planning/Designing	14	48.3	8	72.3
Expanding energy-efficiency knowledge base	20	69	7	63.6
Expanding waste minimization/pollution prevention knowledge base	6	20.7	3	27.3
Expanding process efficiency/productivity knowledge base	11	37.9	5	36.4
Not downloading as support material	3	10.3	0	0
Other (Please specify)[b]	4	13.8	0	0

[a] Percentages do not add up to 100% because of respondents' ability to choose more than one answer.
[b] "Other" responses provided were the following: Research; development of evaluation metrics; not sure if downloading material; if not today maybe later; passing along link and information to others; upgrade of my office's capability.

Question 5: ***Have any of the following actions evolved out of your use of information found on either the Rutgers or CSU Website? (Check all that apply.)***

This question was used as a precursor to the savings set of questions. Those who responded with any answer other than “No action” were asked to complete Questions 6 through 13, while those who responded only with “No action” were asked to skip directly to Question 14. Twelve of the 29 respondents indicated savings of some type (in Questions 6 through 13), for an overall savings rate of just over 41%. Their choices in this question are shown on the right side of Table C.5. The largest number of actions reported were in the energy saving actions (9) and waste reducing actions (7) categories.

Table C.5. Acting on the IAC information obtained

Answer Choices	**Total Responses**		**Savings Responses**											
	No.	**%-out of 29[a]**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Energy saving actions	9	31	✔	✔	✔	✔	✔		✔	✔		✔	✔	
Money saving actions	6	20.7	✔	✔	✔	✔	✔						✔	
Waste reducing actions	7	24.1	✔	✔	✔	✔		✔		✔			✔	
Productivity enhancing actions	5	17.2		✔		✔	✔						✔	✔
Raised concerns for energy efficiency	3	10.3		✔		✔				✔				
No action	18	62.1									✔			

[a] Percentages do not add up to 100% because of respondents’ ability to choose more than one answer.

Question 14: Of the document(s) you obtained, which one was most helpful?

A peculiar aspect of the responses to this question is the number of respondents not answering it (this may be a questionnaire design issue that should be addressed). Sixteen of twenty-nine answered the question, with 13 skipping it (~45%). Of the nine different answer choices offered, three garnered about 56% of the responses:

- IAC database documents,
- Not sure or don't know yet, and
- Haven't seen any yet.

The two documents pinpointed as most helpful to those indicating savings are IAC database documents and the Self Assessment Workbook.

Table C.6. Helpful documents

Answer choices	**Total Responses**		**Savings Responses**	
	No.	**%**	**No.**	**%**
IAC database documents	3	18.8	1	25
A Self Assessment Workbook for Small Manufacturers	2	11.1	1	25
Technological Goodies—Rules of Thumb	1	5.6	0	0
Modern Industrial Assessments: A Training Manual	1	5.6	0	0
Energy Efficiency Handbook (An OIT document)	1	5.6	0	0
Motor Selection Guide (Part of DOE's MotorMaster software)	1	5.6	0	0
Advanced process control improvement (steel)	1	5.6	0	0
Not sure or don't know	3	18.8	1	25
Haven't seen any yet	3	18.8	1	25
Totals	*16*	*100*	4	*100*

Question 15: Have you or did you plan on passing the information you obtained to others, and if so, how many?

This question was posed in attempts to find out the rate at which respondents are passing the information they obtain on to others. From the last calculations in Table C.7, it appears that the number of people that a respondent passes information on to is independent of whether or not they are realizing savings (of any type). Thus, from the results of this questionnaire, it appears that the average site visitor passes on approximately 15 IAC-related documents, either the same document or different documents. Although this may seem odd, note that 6 of the total 28 respondents (more than 21%) chose the largest category (>50 people), and the average for that range had to be the conservative minimum value of 50.

It should also be noted that the estimates of savings generated by IAC Web users have not been adjusted with respect to the responses to this question. Even a conservative estimate of more savings would have driven the total savings upward even further.

Table C.7. Passing information to others

Answer Choices[a]	Average of Range	Total Responses No.	Total Responses %	Savings Responses No.	Savings Responses %	Average No. of Responses[a] Total	Average No. of Responses[a] Savings
Didn't plan on it or 0	0	4	14.3	2	16.7	---	0
1	1	4	14.3	1	8.3	4	1
2–5	3.5	8	28.6	4	33.3	28	14
6–10	8	3	10.7	1	8.3	24	8
10–20	15	1	3.6	0	0	15	---
20–50	35	2	7.1	2	16.7	70	70
> 50	50	6	21.4	2	16.7	250	50
Total number of additional recipients		*28*	*100*	*12*	*100*	*391*	*143*
Average number of additional recipients per original user (dividing by the number of respondents, 28 and 12, respectively)						*14.5*	*13.1*

[a]Number of additional recipients.

Questions 16–21: Assessing changed attitudes from the use of online IAC information (Decision Making Model)

Questions 16–21 were posed in order to explore how the use of IAC online technical information has changed a company's or an organization's perspectives on identifying and implementing energy efficiency opportunities. The responses received are addressed in Sect. 6; thus, the responses are not addressed here.

Question 22: How satisfied were you with the information you obtained from the Rutgers or CSU Website?

From the responses to this answer, it appears that the vast majority (96.2%) of visitors to the IAC Web sites that host technical information are pleased with the information they obtain.

Table C.8. Website users' satisfaction

Answer Choices	**No. of responses**	**% of total responses**
Extremely satisfied	12	42.6
Satisfied	15	53.6
Indifferent	1	3.6
Dissatisfied	0	0
Extremely dissatisfied	0	0
Totals	*28*	*100*

Question 23: How easy would you say it was to access the information on the Web site?

The total shown in the bottom of Table C.9 (20) is much lower than the total number of visitors completing questionnaires (29) because of approximately 33% of the respondents skipped this question. However, the results reveal that the average site visitor finds the online information easy to access.

Table C.9. Ease of access

Answer Choices	**No. of responses**	**% of total responses**
Very easy	0	0
Easy	14	70
Of average easiness/difficulty for the Web	6	30
Difficult	0	0
Very difficult	0	0
Totals	*20*	*100*

Question 24: What format do you prefer for downloadable documents?

More than 50% of respondents noted that they prefer PDF (portable document format) files to other formats for downloadable documents. Running a close second (about 38%) was the preference of Microsoft-based products.

In the past several years, PDF files have begun to be widely used on the World Wide as the format for downloadable and directly printable documents. Because several different types of documents can be turned into PDF files (including but not limited to spreadsheets and word processing documents), and the documents appears exactly the same on any PDF-capable browser, this format provides an advantage over Microsoft and Corel documents by removing the software bias. However, providing documents in at least two different formats typically offers the site visitor the greatest flexibility in easily obtaining and utilizing online information. For example, one respondent commented to the questionnaire:

> *"My company currently supports Microsoft programs. I found it hard to correctly convert recommendations, and impossible to convert spreadsheets. Maybe have an alternative format in addition to those currently available."*

Perhaps this type of questionnaire could be used to determine the format preferences of visitors to the two Websites where IAC technical information is offered, so that these two sites could offer the documents they provide online in at least two different formats. At present, Rutgers offers documents in html, dbf (a software-independent format) and PDF formats; and CSU offers documents in Corel software formats. The Rutgers Website also offers access to the IAC database through an interactive interface. However, that interface presently provides limited usefulness in accessing the database.

Table C.10. Downloadable documents preferences

Answer choices	**No. of responses**	**% of total responses**
PDF (portable document format)	15	51.7
Word, Excel, and Access (Microsoft)	11	37.9
Word Perfect, Quattro Pro, and Paradox (Corel)	0	0
No preference	3	10.3
Totals	*29*	*100*

Question 25: What recommendations do you have for improving either the content or the usability of the Rutgers or CSU Websites?

Only 12 of the 29 respondents offered recommendations for improving the content or usability of the two Websites, with 3 of those simply stating "thanks." Of the recommendations, only 2 were critical in nature, suggesting that more "technical goodies" be added and that placing documents in Microsoft program formats would help.

Table C.11. Recommendations for improvement

Responden t	Comments provided
1	I came online searching for a list of all the Universities participating in the IAC Program—and the information was very easy to find.
2	Information received is used to train other energy engineers, primarily while teaching at the University level. However, this information is used currently for measurement and verification tasks.
3	The NH Governor's Office of Energy and Community Services is developing a training program to develop volunteers from the business community to perform peer-to-peer industrial assessments. The information you provided is critical to the development of this training module. Many of the questions above do not directly apply because we are in the development stage, but we will be glad to share our data at a later date.
4	No suggestions. I am quite pleased with the way this data can be accessed and used. This is a tremendous improvement over things the last time I used this data.
5	Add more "technical goodies" or other items that can be used as screening tools.
6	I like some of your titles – tech goodies for example.
7	Keep it up, well done.
8	My company currently supports Microsoft Programs. I found it hard to correctly convert recommendations, and impossible to convert spreadsheets. Maybe have an alternative format in addition to those currently available.
9	I don't really know yet. Question No. 22 has no space for "I am filling out the questionnaire before accessing any information." Some of the following questions have similar problems because there are no spaces to answer correctly because I filled out the questionnaire before doing anything at all. I have not accessed any databases or anything else. I have not implemented anything yet for the same reasons.
10	Would appreciate the ability to drill down another layer regarding the top 10 recommendations for any SIC (within the IAC Databases).
11	Make the links to your FTP site obvious.
12	Maybe I missed it today but a search engine for your site would be great.

Question 26: Personal information, demographics

The geographical diversity shown from the 29 respondents literally spans the globe. Other demographic information derived from the responses included that 25 males and 3 females responded to the Web questionnaire (one respondent used abbreviations for his or her name).

Table C.12. Geographical locations of respondents

U.S. State	No. of respondents	Other Countries	No. of respondents
California [a]	3	Bulgaria	1
Colorado	1	Germany	1
Florida [b]	1	The Netherlands	1
Illinois [b]	3	Canada (Ontario) [b]	1
Kansas	1	Pakistan [b]	1
New Hampshire	1	Spain [b]	1
New Jersey	2	Taiwan [b]	1
Pennsylvania	1		
Tennessee	1		
Vermont [b]	3		
Virginia [a]	3		
Washington	2		
Domestic total	22	*Foreign total*	7

[a] Two respondents (out of the total number responding for this location), provided details on energy and/or cost savings.
[b] One respondent (out of the total number responding for this location), provided details on energy and/or cost savings.

Question 27: What is your current occupation?

Although 65% of those using online IAC technical information are either engineers or consultants, the responses highlight the diversity of the user base.

Table C.13. Occupations of participants

Answer Choices	**Total responses**		**Savings responses**	
	No.	**%**	**No.**	**%**
Engineer	11	45	5	45.5
Consultant	7	20	3	27.3
Manager	3	10	1	9.1
Scientist/researcher	2	5	1	9.1
Academic/student	1	5	1	9.1
Other (Please specify)[a]	5	15	0	0
Totals	*29*	*100*	*11*	*100*

[a] "Other"categories supplied included the following five responses: grants coordinator/economist, economist, grants and contracts, industrial insulation project manager/salesman/estimator, and marketing and business development.

Question 28: ***Which of these groups best describes your affiliation/organization for which you were accessing the Web site?***

The responses to this question clearly indicate a diverse group of visitors to the IAC Websites (based on affiliation); however, 48.3% are either industrially or commercially based. For the respondents reporting savings, the percentage that are either industrially or commercially based dwindles to 24.1%. This decrease appears mostly related to a percentage increase in the nonprofit organization category.

In additional, the response spread for all respondents is similar to that of the respondents reporting savings.

Table C.14. Affiliation or organization of participants

Answer choices	**Total Responses**		**Savings Responses**	
	No.	**%**	**No.**	**%**
Large industrial	5	17.2	3	27.3
Small industrial	4	13.8	1	9.1
Large commercial	3	10.3	1	9.1
Small commercial	2	6.9	1	9.1
Residential/consumer/private citizen	0	0	0	0
Federal government	2	6.9	0	0
State/local government	2	6.9	0	0
Nonprofit organization	5	17.2	4	36.4
Educator	1	3.5	1	9.1
Student	0	0	0	0
Other (Please specify)[a]	5	17.2	0	0
Totals	*29*	*100*	*11*	*100*

[a] Those choosing the "Other" category listed the following affiliation/organizations: DOE national laboratory, environmental consulting for federal government, industrial insulation contractor, electric utility, university outreach for all of the categories suggested as answers in this question.